

**ALLIED PAPER, INC./PORTAGE CREEK/  
KALAMAZOO RIVER SUPERFUND SITE  
REMEDIAL INVESTIGATION/  
FEASIBILITY STUDY WORK PLAN**

**Kalamazoo River Study Group**

**Allied Paper, Inc./Portage Creek/Kalamazoo River  
Superfund Site**



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Kalamazoo River Superfund Site  
Remedial Investigation/  
Feasibility Study Work Plan***

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Superfund Site

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SUPERFUND SITE  
RI/FS WORK PLAN**

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- Appendix D Plan for the Use of Immunoassay Field Screening Kits

**FIELD SAMPLING PLAN (separately bound)**

**ASSOCIATED DOCUMENTS AND PLANS (provided separately)**

1. Description of Current Situation
2. Health and Safety Plan
3. Quality Assurance Project Plan
4. QA/QC Review of Historical Studies and Data Plan
5. Data Management Plan
6. Plan for Satisfaction of Permitting Requirements
7. Allied Paper, Inc. Operable Unit Work Plan and Field Sampling Plan
8. King Highway Landfill Operable Unit Work Plan and Field Sampling Plan
9. Willow Boulevard/A-Site Operable Unit Work Plan and Field Sampling Plan
10. 12<sup>th</sup> Street Landfill Operable Unit Work Plan and Field Sampling Plan

## **SECTION 1 - INTRODUCTION**

### **1.1 Overview**

The Kalamazoo River Study Group (KRSB), comprised of HM Holdings, Inc./Allied Paper, Inc., Georgia-Pacific Corporation, and Simpson Plainwell Paper Company, is performing, under an Administrative Order by Consent (AOC), a Remedial Investigation and Feasibility Study (RI/FS) at the Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund Site. The RI/FS is the principal requirement of the AOC, which was executed on December 28, 1990, between the Michigan Department of Natural Resources (MDNR) and the KRSB.

The Superfund Site, as defined in the National Priorities List (NPL Site), includes three miles of Portage Creek and 35 miles of the Kalamazoo River from the city of Kalamazoo to the city of Allegan.

The entire area subject to this RI/FS Work Plan is being referred to in this document as the "Site". The specific areas to be investigated as directed by MDNR as part of the Site are:

- Kalamazoo River from the Morrow Lake Dam to Lake Michigan;
- Portage Creek from Alcott Street to the Kalamazoo River;
- Georgia-Pacific Corporation Kalamazoo Mill property;
- Simpson Plainwell Paper Company Mill property;
- Portage Paper Mill property;
- Former King Mill property;
- Former Monarch Mill property; and
- King Street storm sewer outfall.

Four operable units (OUs) were established to allow RI/FS activities to proceed along different schedules based on historical information and the nature of the OUs. These OUs are:

- Allied Paper, Inc. Operable Unit (including former Bryant Mill Pond);
- King Highway Landfill Operable Unit;
- Willow Boulevard/A-Site Operable Unit; and
- 12th Street Landfill Operable Unit.

While the entire Site will undergo a RI/FS, each OU will undergo a Remedial Investigation and Focused Feasibility Study (RI/FFS). A separate Record of Decision (ROD) will be developed for the NPL Site and each OU.

This Work Plan describes the proposed RI/FS activities for the Kalamazoo River from Morrow Lake Dam to Lake Michigan, Portage Creek from Alcott Street to the Kalamazoo River, Georgia-Pacific Corporation Kalamazoo Mill property, Simpson Plainwell Paper Company Mill property, Portage Paper Mill property, former King Mill property, former Monarch Mill property, and the King Street Storm Sewer. Figure 1 presents a general location map of the Site. Figure 2 presents the index map of the more detailed Site maps illustrated in Figures 3 through 19.

#### 1.1.1 Development of RI/FS Scope of Work

As required by the AOC, the KRSG submitted in March 1991 a draft RI/FS Work Plan to MDNR pertaining to the Kalamazoo River, Portage Creek, the former Bryant Mill Pond area, and the Allied Paper, Inc. paper-making residuals dewatering lagoons and residuals disposal area. The MDNR responded with comments on July 24, 1991, which included the requirement that the NPL Site be expanded to include various "operable units" that may

be sources of polychlorinated biphenyls (PCBs) to the Kalamazoo River and Portage Creek (Bradford, 1991a),

On August 12, 1991, the KRSO notified MDNR of their objection to the inclusion of additional areas to be investigated under paragraph 36 of the AOC - Dispute Resolution (Brown, 1991a). MDNR directed the KRSO to include these additional areas to be investigated as part of the Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund Site RI/FS. On December 3, 1992, MDNR formalized the requirement to conduct a RI/FFS at each of the OUs: Allied Paper, Inc. (including the former Bryant Mill Pond area, a portion of Portage Creek, and the residuals dewatering lagoons and residuals disposal area), 12th Street Landfill, Willow Boulevard/A-Site, and King Highway Landfill (Bradford, 1992).

#### 1.1.1.1 Kalamazoo River/Portage Creek Sampling

The initial Work Plan submitted to MDNR on March 27, 1991 by Blasland & Bouck Engineers, P.C. (Blasland & Bouck) on behalf of the KRSO included a hydrodynamically-focused sediment sampling plan based on PCB physical characteristics (i.e., sorption to fine-grained particles), whereby PCBs would be expected to be located in areas of fine-grained sediment deposition. This approach has been successfully implemented at other PCB aquatic sites, such as Sheboygan River, Fox River, and New Bedford Harbor (Blasland & Bouck, 1990; Ikalainen and Allen, 1988).

In response to the draft Work Plan, MDNR directed that a fixed grid sampling network be established and provided guidance on the structure of the grid system (Bradford, 1991a). Further technical guidance was provided by the United States Environmental Protection

Agency (USEPA) Environmental Monitoring Systems Laboratory (EMSL) regarding the design of a geostatistical approach to Kalamazoo River sediment sampling.

In April 1992, the MDNR provided guidance on a Phase I Kalamazoo River and Portage Creek sediment and soil sampling plan. This guidance was based on an interpretation of the large historical PCB database for the former Bryant Mill Pond area sediments. Blasland & Bouck submitted comments on the Phase I guidance to MDNR on May 23, 1992 (Brown, 1992a).

Blasland & Bouck submitted a revised soil and sediment sampling plan to the MDNR and USEPA on May 29, 1992 (Brown, 1992b). MDNR's response to the May 29, 1992 proposal directed that sampling the sediment of the Kalamazoo River for PCB analyses should be conducted after the sediment had been characterized, and that the characterization should be included as part of Phase I activities. MDNR directed that the floodplain soil and the exposed sediment investigation should also be included in Phase I. MDNR and USEPA also required that a geostatistical sampling approach pilot study run concurrently with the sediment characterization study (Cornelius, 1992c).

On November 19, 1992, the MDNR transmitted guidelines for sampling sediment, exposed sediment at former impoundments, and floodplain soils (Cornelius, 1992d). The correspondence included a proposed geostatistical sampling pilot study plan. This plan was further discussed at a technical meeting between MDNR and representatives of the KRSRG on December 3, 1992. A further refined

plan was transmitted to MDNR on December 8, 1992 (Brown, 1992c). The December 8, 1992 proposal was conditionally accepted by MDNR on January 9, 1993.

Additionally, in comments on the Work Plan, MDNR determined the area to be investigated should be extended to the furthest downstream point of potential PCB transport (Bradford, 1991a). At the November 26, 1991 technical meeting, the existing PCB analytical data collected downstream of Lake Allegan was reviewed and the KRSR agreed to further study this section of the Kalamazoo River. The objectives of sediment sampling downstream of Lake Allegan would be to characterize PCB concentrations currently accumulating in surficial sediment and to reconstruct a PCB transport chronology from the sediment record of Kalamazoo Lake. In subsequent correspondence, the MDNR concluded that a phased sediment sampling approach to the Kalamazoo River downstream of Lake Allegan was appropriate and that the RI in this area should focus on areas of ecological significance, such as Swan Creek Marsh (Beebe and Cornelius, 1992).

#### 1.1.1.2 Mill Sampling

Early in the scoping process, MDNR directed the KRSR to conduct field sampling at the Simpson Plainwell and Portage (previously called Performance) Paper Mills. Later, MDNR directed that the Work Plan should be modified to include field-sampling activities at Georgia-Pacific Corporation Kalamazoo Mill, former King Mill, and former Monarch Mill, to determine whether there are PCBs or other constituents of interest which may potentially accumulate, and whether

these areas act as sources to the Kalamazoo River and Portage Creek (Bradford, 1991b).

In the August 30, 1991 technical meeting, MDNR directed that a phased approach initially focusing on PCBs, polychlorinated dibenzo-p-dioxins (PCDDs), and polychlorinated dibenzofurans (PCDFs) at historic lagoon areas, clarifiers, and stormwater conveyances be implemented.

At a November 8, 1991 technical meeting, Blasland & Bouck and MDNR refined the initial sampling plan for the mill investigations. This sampling plan was subsequently articulated in a formal proposal to the MDNR in correspondence dated November 22, 1991 (Brown, 1991b).

In a letter dated February 11, 1992, MDNR responded to the November 22, 1991 correspondence by agreeing with the approach for identifying and sampling solid residuals rather than water samples in the stormwater conveyances. The MDNR also stated that a contingency for additional sampling should appear in the revised Work Plan. The MDNR further required that the former Monarch Mill property be included in the Phase I sampling program (Beebe and Cornelius, 1992).

At the February 12, 1992 technical meeting, the KRSG agreed to the phased approach and to establish appropriate thresholds for additional sampling specific to the sample media and potential for migration. The KRSG also agreed to include the former Monarch Mill property and that RI sampling would include all known and historic lagoons and historic clarifiers. The Monarch Mill clarifier will be addressed as part of the Allied Paper, Inc. OU RI/FFS.

#### 1.1.1.3 Purpose of the RI/FS Work Plan

The Work Plan serves as the guiding document for the RI/FS. It describes in general terms the type of work to be performed at the Site consistent with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) (40 CFR 300), USEPA's "Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA" (USEPA, 1988a), USEPA's "Guidance on Remedial Actions for Superfund Sites with PCB Contamination" (USEPA, 1990a), the Michigan Environmental Response Act (Act 307), and other appropriate state and federal guidance documents.

The Work Plan defines the scope of the proposed RI/FS tasks in detail and presents the program schedule. The Work Plan is intended to be a flexible and dynamic document. If potential additional tasks are identified as a result of information produced by the RI, the Plan would be reviewed accordingly. Further, the Work Plan identifies data that is needed to develop and evaluate remedial alternatives and to execute the FS tasks.

#### 1.2 Objectives of the RI/FS

As described in the AOC, the results of the RI will be used to determine the nature and extent of constituents of interest present in sediments, residuals, floodplain soils, groundwater, and surface water, and the potential, if any, for threats to public health, welfare, or the environment caused by the release or threatened release of constituents of interest from the Site.

The goals of the RI as stated in the AOC are to:

- Characterize the nature of paper-making residuals at the Site;
- Define regulated constituent sources at the Site;
- Determine the vertical and horizontal extent of regulated constituents originating at the Site;
- Spatially quantify regulated constituents to the extent necessary to enable preparation of an Endangerment Assessment (EA) and a FS, to the extent that such constituents may be attributable to the Site;
- Identify potential regulated constituent migration pathways and movement; and
- Quantify public health and environmental risk.

The quantification of public health and environmental risk is the responsibility of MDNR under the AOC. This Work Plan proposes the collection of data which will be used in part for the EA tasks, but does not define the EA tasks. These tasks are defined in MDNR-authored documents.

The specific subset of objectives for the RI developed during technical meetings is to:

- Characterize the sediments along transects of the Kalamazoo River and Portage Creek;
- Characterize the distribution of PCBs in the sediment and floodplain soils;
- Assess volumes of sediment associated with various PCB levels in the Kalamazoo River and Portage Creek;
- Assess the nature of PCB transport in the Kalamazoo River and Portage Creek, and, in particular, assess the potential for the erosion and resuspension of sediments that contain PCBs;

- Characterize the presence of PCBs and constituents on the USEPA Contract Laboratory Program Target Compound List and Target Analyte List (CLP TCL/TAL) in the sediment and floodplain soils;
- Characterize the hydrologic, hydrogeologic, and geologic conditions at the Site; and
- Determine if constituents of interest are being released to or from the Site via groundwater discharges.

The purpose of the FS is to develop, screen, and evaluate alternatives for remedial action and to recommend the preferred remedy. The FS involves four general phases: development of a range of remedial alternatives, screening of the remedial alternatives, detailed analysis of the retained alternatives deemed potentially viable during the screening phase, and comparative evaluation of alternatives. These phases are described in Section 6.

Upon completion of the screening phase, applicable or relevant and appropriate requirements (ARARs) relating to the remaining remedial alternatives will be developed. During this process, an alternatives array document will be prepared to summarize Site description, technology identification and screening, and to further evaluate and screen alternatives.

The objectives of the FS are as follows:

- Develop remedial objectives;
- Develop and evaluate remedial alternatives; and
- Recommend a preferred alternative.

### 1.3 Scope of the RI/FS Work Plan

The scope of the RI/FS Work Plan encompasses the activities required to meet the objectives presented in the preceding section. This Work Plan

describes studies to be conducted at the Site including a statement of sampling objectives, analyses, sample types, sample locations and frequency, and schedule. The Work Plan also identifies appropriate data that will be needed to evaluate remedial alternatives for the FS. Work tasks associated with individual OUs are contained in the OU-specific Work Plans.

Although the RI/FS will primarily focus on PCBs, as directed by MDNR, samples of various environmental media will be analyzed for CLP TCL/TAL constituents, PCDDs, and PCDFs to determine whether there is an unacceptable increase in risk posed by the levels of other constituents found to be present. The geographic scope of this Work Plan includes three miles of Portage Creek, 35 miles of the Kalamazoo River, and the other areas discussed in Section 1.1. Morrow Lake and the portion of the Kalamazoo River adjacent to Fort Custer Recreational Area, both of which are upstream of the Site and the KRSG facilities, will serve as reference areas during the RI.

## **SECTION 2 - PHYSICAL SETTING AND SITE CHARACTERISTICS**

### **2.1 Physical Setting**

The Kalamazoo River and a tributary of interest, Portage Creek, are located in southwestern Michigan (Figure 1). The main stem of the Kalamazoo River begins in Albion, Michigan at the confluence of the North and South Branches, and flows northwesterly for 123 miles through Kalamazoo and Allegan Counties to Lake Michigan. The Kalamazoo River drains an area of approximately 2,000 square miles, and is fed by more than 400 miles of tributaries. The general physical characteristics of segments of the Kalamazoo River and Portage Creek being investigated are summarized in Table 2-1.

The Kalamazoo River basin is characterized topographically by hills and valleys, irregular plains, ponds, and lakes, and is part of the South Michigan/Indiana Till Plains Ecoregion (Omernik, 1986). Upland areas in the Kalamazoo River basin support industrial, commercial, and recreational use, as well as urban and suburban residential development. Rural areas in the Kalamazoo River basin consist of a combination of cropland, pasture land, woodland, and forest. Bottomlands along the Kalamazoo River form extensive flats, and are distinguished by muck soils, a relatively high groundwater table, and extensive wetland areas (MDNR, 1987b).

In general, the Kalamazoo River has a moderate gradient. In many locations along the Kalamazoo River where gradients are higher, the river has been historically impounded for hydroelectrical and other industrial purposes. A total of three active impoundments (Otsego City, Allegan City, and Lake Allegan) and three former impoundments (Plainwell, Otsego, and Trowbridge) are included in

the NPL Site. All of the impoundments were formed by dams originally used for the production of hydroelectric power.

MDNR is the current owner of the Plainwell, Otsego, and Trowbridge dams. Although MDNR removed the superstructure of the dams, the sills to these dams still remain and impound water (MDNR, 1988b). Two other dams, the Allegan City and Lake Allegan dams, continue to produce hydroelectric power, while the Otsego City Dam is no longer used for power production. Lake Allegan, the largest of the impoundments, serves as a recreational area on the Kalamazoo River. Further downstream, the River flows through the Allegan State Game Refuge before emptying into Lake Michigan.

Along its course, the Kalamazoo River passes through a number of municipalities. These include Albion (population 10,000), Marshall (population 7,000), Battle Creek (population 54,000), Augusta (population 1,000), Galesburg (population 2,000), Comstock (population 11,000), Kalamazoo (population 80,000), Parchment (population 2,000), Plainwell (population 4,000), Otsego (population 4,000), Allegan (population 4,700), Douglas (population 950), and Saugatuck (population 1,100).

The NPL Site also includes the lower three miles of Portage Creek, a tributary which joins the Kalamazoo River at Kalamazoo, Michigan (Figure 2). Portage Creek begins in Portage, Michigan, and including its West Fork, flows a distance of approximately 18.5 miles. The lower segment of Portage Creek passes through residential and industrial areas of Kalamazoo (Figure 4).

A more extensive review of the physical setting and characteristics of the Site is contained in the draft "Description of Current Situation" (DCS) Report (Blasland & Bouck, 1992).

### 2.1.1 Climate

The Kalamazoo River basin is characterized generally by a temperate climate with warm, humid summers and cold winters. Prevailing winds are from the west-southwest. The mean summer and winter temperatures are approximately 70°F and 28°F, respectively. Temperature extremes include a high of 104°F on July 13, 1936, and a low of -20°F on February 11, 1899, as reported for Allegan, Michigan (NOAA, 1989). Meteorological data recorded during the period 1951 to 1980 for Allegan and Kalamazoo Counties are summarized in the DCS Report (Table 1).

Annual precipitation in the Allegan-Kalamazoo County area averages approximately 35 inches per year, with slightly more than 55 percent of this amount occurring between April and September (NOAA, 1989). Approximately 12 inches of precipitation leaves the basin annually as discharge through the Kalamazoo River, while the remaining 23 inches is accounted for as recharge to aquifers and evapotranspiration (Rheaume, 1990).

### 2.1.2 Hydrology

Discharge of the Kalamazoo River and Portage Creek is monitored by the United States Geological Survey (USGS) at gauging stations located on the Kalamazoo River, Portage Creek, and the West Fork of Portage Creek. The average flow at the Comstock gauging station, located on the Kalamazoo River approximately one mile below the Morrow Lake Dam, is 870 cubic feet per second (cfs), with a minimum flow of 120 cfs, and a maximum flow of 6,910 cfs during the period of record from 1933 to 1979 and 1984 to 1989 (USGS, 1990).

Flow at the Fennville gauging station, located four miles below the Lake Allegan Dam, averaged 1,450 cfs over the period of record from 1929 to 1989. The corresponding minimum and maximum flows recorded at Fennville are 50 cfs and 17,500 cfs, respectively. The Fennville location also serves as a National Stream Quality Accounting Network station (USGS, 1990), part of a long-term nationwide surface water quality monitoring program.

The drainage area associated with the Portage Creek gauging station near Kalamazoo is approximately 22 square miles. During the period of record from 1964 to 1990, streamflow averaged 40 cfs, with minimum and maximum flows of 8 cfs and 407 cfs, respectively (USGS, 1990).

The drainage area of the West Fork Portage Creek at the Kalamazoo USGS gauging station is 18.7 square miles. The average flow during the 1959 to 1989 period of record is 9.7 cfs, with a minimum of 1 cfs and a maximum of 41 cfs (USGS, 1990). The confluence of the West Fork with the main stem of Portage Creek is downstream of the main stem gauging station and upstream of Monarch Mill Pond.

### 2.1.3 Geology

General soil associations and soil complexes in Kalamazoo and Allegan Counties are described in their respective county soil surveys (Austin, 1979; Knapp, 1987). In general, the soil in the area is described as ranging from nearly level to steep, and from poorly drained to well drained. The soils have loamy to sandy and loamy subsoils formed in glacial outwash and morainic deposits.

The region's topography was derived from the occurrence of several continental glaciers. The area was primarily influenced by the Wisconsin

glacial period that occurred approximately 15,000 to 17,000 years ago. During this period, two large ice lobes, the Saginaw and Michigan, merged near the city of Otsego. The melting of the lobes and subsequent deposition of the entrained material gave rise to the present day landforms.

During the retreat of the ice lobes, the Saginaw lobe front moved to the northeast and the Michigan lobe front to the northwest, producing large quantities of outwash sand and gravel deposits which formed the Galesburg-Vicksburg outwash plain. Also, throughout this period, large blocks of ice broke away from the main ice body and were buried by outwash sediments. As the buried ice slowly melted, the overlying sand and gravel collapsed to form the many kettle lakes found throughout the area (Rheaume, 1990).

The retreat of the ice lobes halted in western Kalamazoo and Allegan counties. In this position, the ice lobe deposited sandy to very sandy till and massive to poorly bedded cobbly sand with isolated lenses and pockets of sandy clay. This depositional event formed the Kalamazoo Moraine, which is one of the largest continuous ridges in southern Michigan (Rheaume, 1990).

As the ice lobes continued to retreat, a drainageway was opened in front of the Michigan Lobe. Meltwaters that had been draining to the south ponded in the center of Kalamazoo County. The direction of flow changed from south to north, resulting in downcutting of the outwash plain and formation of the down-cut glacial drainage channels of the Kalamazoo River Valley.

The glacial deposits range in thickness from approximately 50 feet to 200 feet and overlie the Coldwater Shale formed during the Mississippian

Period of the Paleozoic Era. The shale is greater than 500-feet thick and dips to the northeast (Rheaume, 1990).

The region's primary groundwater sources are associated with glacial deposits of sands and gravels. Water wells in these areas range in depth from approximately 25 to 325 feet, although most domestic wells are less than 75 feet deep (Rheaume, 1990).

## **2.2 Site Characteristics**

### **2.2.1 Areas Subject to RI Activities**

The following sections summarize the general characteristics of areas subject to RI activities. More detailed descriptions of these areas are presented in the DCS Report. The specific areas to be investigated are listed below:

- Portage Creek, from Alcott Street to its confluence with the Kalamazoo River.
- Kalamazoo River, from Morrow Lake Dam to Lake Michigan. This segment of the River covers approximately 76 miles. For descriptive purposes, this stretch of River is divided into the following nine segments:
  - Morrow Lake Dam to the Portage Creek Confluence (Figures 3 and 4);
  - Portage Creek Confluence to Main Street, Plainwell (Figures 4, 5, 6 and 7);
  - Main Street, Plainwell to the Plainwell Dam (Figure 7);
  - Plainwell Dam to the Otsego City Dam (Figure 7);
  - Otsego City Dam to the Otsego Dam (Figures 7 and 8);

- Otsego Dam to the Trowbridge Dam (Figure 8);
  - Trowbridge Dam to the Allegan City Dam (Figure 9);
  - Allegan City Dam to Lake Allegan Dam (Figures 9 and 10);  
and
  - Lake Allegan Dam to Lake Michigan (Figures 11, 12, and 13).
- Georgia-Pacific Corporation Kalamazoo Mill property (Figure 14).
  - Simpson Plainwell Paper Company Mill property (Figure 15).
  - Portage Paper Inc. Mill property (Figure 16).
  - Former King Mill property (Figure 17).
  - Former Monarch Mill Property (Figure 18).
  - King Street Storm Sewer (Figure 19).
  - Morrow Lake (Figure 3).

The summary of known concentrations of PCBs for sediment, water-column, and fish for each segment of the Kalamazoo River is contained in Tables 2-2, 2-3, and 2-4, respectively.

#### 2.2.2 Portage Creek from Alcott Street to the Kalamazoo River

The lower segment of Portage Creek, from Alcott Street downstream to the Kalamazoo River confluence, is shown in Figure 4. The Allied Paper, Inc. OU is immediately upstream of this segment. Along this segment the Creek passes through urbanized areas of the city of Kalamazoo, and as a result, a large portion of the Creek has been channelized to reduce the potential for flooding.

The lands adjacent to lower Portage Creek are highly developed, containing commercial and industrial zones along the Creek north of Alcott Street as well as near the Kalamazoo River confluence. This area contains

the Upjohn Company's Henrietta Street facility. The Creek is in proximity to residential areas, as well as to Upjohn Park, a recreational area.

2.2.3 Kalamazoo River, Morrow Lake Dam to the Portage Creek Confluence

The upstream segment of the Kalamazoo River between the Morrow Lake Dam and Portage Creek (Figures 3 and 4) is approximately 4 miles long with an average width and depth of 40 feet and 2.5 feet, respectively (Rheaume, 1990). The Kalamazoo River flows westerly over a bed predominantly consisting of gravel, sand, logs, and detritus (MDNR, 1982). Several vegetated sand bars have formed in this segment, as indicated in 1991 aerial photographs presented in the DCS, (Figures 37 to 45). Average flow at the USGS gauging station in Comstock, located in the upper portion of this segment, is approximately 870 cfs (USGS, 1990).

This relatively short segment of Kalamazoo River passes through areas which vary widely in degree of development. The land surrounding the upper end of the segment below Morrow Lake Dam is distinguished by forest. Downstream, the Kalamazoo River passes through residential and commercial areas in the town of Comstock, and flows through forested areas as it continues below Comstock. Below Comstock, the former Kalamazoo Wastewater Treatment Plant (WWTP) sludge disposal area, the former James River Corporation Service Products Division, and the Auto Ion Superfund Site lie adjacent to or near the Kalamazoo River.

Areas to be investigated in this segment of Kalamazoo River include the Georgia-Pacific Corporation Kalamazoo Mill property, the King Highway Landfill OU, and the Willow Boulevard/A-Site OU.

The Kalamazoo River contains two oxbows in this segment, and is joined by a small tributary, Davis Creek, approximately 2.5 miles below Morrow Lake Dam. A number of industries are located within the Davis Creek drainage area, including American Cyanamid Company, FabriKal Corporation, General Motors Corporation - BOC (Buick, Oldsmobile, and Cadillac) Group plant, as well as the Cork Street Landfill Superfund Site.

2.2.4 Kalamazoo River, Portage Creek Confluence to Main Street,  
Plainwell

The segment of the Kalamazoo River between Portage Creek and Plainwell (Figures 4 through 7) is 14.3 miles long and is relatively shallow (1 to 3 feet deep). This segment of the Kalamazoo River has been characterized as an erosional zone (NUS, 1986) with a predominantly sand and gravel bottom (MDNR, 1984b).

The floodplain in the upstream portion of this segment, in the city of Kalamazoo, supports extensive industrial development. Major facilities in this area include A-1 Disposal, Inc.; Acme Printing Ink Company; Checker Motors Corporation; the Paperboard Packaging Group and Specialty Papers Division of the James River Corporation; Hercules, Inc.; North American Aluminum Corporation; former Shakespeare Company; United Technologies, Inc.; and the former Eaton Corporation-Fuller Transmission facility. Numerous other smaller industries reside along this segment of the Kalamazoo River. The River receives discharge from the Kalamazoo Water Reclamation Plant along this segment.

Downstream of the city of Kalamazoo, the riverbank is less developed, and the Kalamazoo River passes through rural lands for the next nine miles. In this rural segment, the Kalamazoo River passes by an extensive sand

and gravel operation between Avenues C and D in Cooper Township. Further downstream near Plainwell, the Kalamazoo River again flows through areas of suburban and urban development.

In addition to Portage Creek, tributaries to the Kalamazoo River in this segment include Silver Creek and Spring Brook, as well as a number of small unnamed streams.

#### 2.2.5 Kalamazoo River, Main Street, Plainwell to the Plainwell Dam

The segment of the Kalamazoo River between Main Street, Plainwell and the Plainwell Dam is approximately two miles long and consists chiefly of the former Plainwell Impoundment (Figure 7). The Plainwell Dam was previously operated to generate hydroelectric power. Following acquisition by MDNR in 1966, the dam was dismantled down to its sill level in 1987.

The original dam structure raised the Kalamazoo River level by 13 feet, creating a backwater area of approximately 123 acres (Miller, 1966). The sill of the Plainwell Dam currently impounds water with a surface elevation 5 feet above the downstream Kalamazoo River level (MDNR, 1988b). A portion of the PCBs transported in the Kalamazoo River evidently was deposited with sediments at the bottom of the former 123-acre impoundment (Blasland & Bouck, 1992).

As a result of the dam removal, sediments in portions of the previously impounded area are now exposed on the banks of the existing impoundment. These exposed areas have become overgrown with typical marsh-type vegetation.

The upper end of this segment of Kalamazoo River is located in the city of Plainwell, which contains industrial, commercial, and residential development. Both the Simpson Plainwell Paper Company Mill and the

Plainwell WWTP are located within the city. Downstream of Plainwell, the Kalamazoo River flows through rural lands. No major tributaries exist in this segment of the Kalamazoo River.

#### 2.2.6 Kalamazoo River, Plainwell Dam to the Otsego City Dam

This 1.7-mile segment of the Kalamazoo River downstream of the Plainwell Dam is impounded by the Otsego City Dam (Figure 7). The upper portion of this segment is braided, and is also characterized by small sand bars.

The Otsego City Dam, also known as the Menasha Dam, maintains a water-surface elevation which is 8.5 feet above the downstream Kalamazoo River level, and impounds approximately 500 acre-feet of water. The dam previously generated electricity for the town of Otsego.

The upper portion of this segment of Kalamazoo River is predominantly rural, with limited agricultural lands, woodlands, and forests. The shoreline adjacent to the Otsego City Impoundment is characterized as a marsh wetland (NUS, 1986). Limited residential development characterizes the lower portion of this segment of Kalamazoo River, which includes the 12th Street Landfill OU.

#### 2.2.7 Kalamazoo River, Otsego City Dam to the Otsego Dam

This segment of Kalamazoo River is 3.3 miles long from Otsego City Dam to the Otsego Dam (Figures 7 and 8). The upstream portion of this segment of Kalamazoo River supports industrial development in the vicinity of the Highway 89 Bridge in the city of Otsego, and includes the Menasha Corporation, Parker-Hannifin Corporation, and Rock-Tenn Company. The downstream portion of this segment is generally rural in character, and is bordered by wetlands in some areas.

banks. Schnable Brook, the sole tributary in this segment, joins the Kalamazoo River approximately 1.5 miles upstream of the Trowbridge Dam (MDNR, 1989b).

The Trowbridge Dam was previously operated to generate hydroelectric power, but following acquisition by MDNR in 1966, was dismantled down to the sill level in 1987. However, the dam still impounds water above the natural Kalamazoo River channel.

The original Trowbridge Dam structure raised the Kalamazoo River level by 21.5 feet, creating a backwater area of approximately 546 acres (Miller, 1966). A portion of the PCBs transported in the Kalamazoo River evidently were deposited with sediments at the bottom of the 546-acre impoundment (Blasland & Bouck, 1992).

At present, the remaining portion of the Trowbridge Dam maintains a water surface 10 feet above the downstream Kalamazoo River level. As a result, sediments in portions of the previously impounded area are now exposed on the banks of the existing impoundment.

#### 2.2.9 Kalamazoo River, Trowbridge Dam to the Allegan City Dam

The 9 mile section of the Kalamazoo River downstream from the Trowbridge Dam includes the 1.7-mile long Allegan City Dam Impoundment (Figure 9). The upper 7.3 miles of the Kalamazoo River above the impoundment has been characterized as an erosional zone, and the impoundment as a depositional zone (NUS, 1986). The Allegan City Dam Impoundment also contains sediments with PCBs (Blasland & Bouck, 1992).

The upper portion of this segment of Kalamazoo River is predominantly rural. Further downstream towards Allegan, the floodplain becomes increasingly developed, with urban areas and a limited industrial area near

the Allegan City Dam. Tannery Creek enters the Kalamazoo River as a tributary approximately 0.2 miles upstream of the Allegan City Dam.

The Allegan City Dam, also known as the Imperial Carving Dam, maintains a water surface nine feet above the downstream Kalamazoo River level, impounding approximately 1,100 acre-feet of water. The dam currently generates electricity for the city of Allegan.

#### 2.2.10 Kalamazoo River, Allegan City Dam to the Lake Allegan Dam

Below the Allegan City Dam, the Kalamazoo River flows a distance of 10.5 miles before reaching the Allegan Dam (Figures 9 and 10). This segment of Kalamazoo River comprises the impoundment formed by the Allegan Dam, known as Lake Allegan and two miles of free-flowing water.

The upper two miles of this segment in Allegan includes residential, commercial, industrial, and recreational development. The Rockwell International Superfund Site and the Allegan County Fairgrounds are located adjacent to the Kalamazoo River in Allegan.

Downstream along Lake Allegan, there is some recreational development especially along the south shore. Public access to the Kalamazoo River includes boat launches and picnic/recreation areas. However, only limited residential development exists along the southern shore.

Dumont Creek forms the main tributary to the Kalamazoo River in this segment, emptying into Lake Allegan from the north. The Allegan WWTP also discharges to the Kalamazoo River in Allegan.

The Lake Allegan Dam, also known as the Calkins Bridge Dam, maintains a water surface 33 feet above the downstream River level, impounding approximately 14,200 acre-feet of water, with an associated surface area of 1,550 acres (MDNR, 1989b). The dam currently generates

hydroelectric power, and is owned and operated by Consumers Power Company.

#### 2.2.11 Kalamazoo River, Lake Allegan Dam to Lake Michigan

The last segment of the Kalamazoo River consists of 28 miles from Lake Allegan Dam to Lake Michigan (Figures 10 through 13). This segment has a drainage area of 460 square miles. The main stream width averages approximately 100 feet, and ranges from approximately 50 to 150 feet. The average depth of much of the Kalamazoo River in this segment is 4 to 6 feet, with areas as deep as 18 feet. The riverbed consists mainly of sand.

The USGS gauging station at Fennville reports an average flow of 1,450 cfs in the lower Kalamazoo River (Rheaume, 1990). This segment receives the flow of a total of 135 miles of tributaries, the largest of which is the Rabbit River.

The banks along the Kalamazoo River are relatively low, typically from 2 to 6 feet in height. As a result, extensive floodplains exist along the main channel, especially in the middle section of this segment of the Kalamazoo River (MDNR, 1987b).

Within the Allegan State Game Area, the Kalamazoo River passes three large marshes, the Koopman, Swan Creek, and Ottawa marshes, as well as the Palmer and Big Dailey Bayous. The Kalamazoo River continues past the Morrison Bayou, a large wetland area, and broadens to form Kalamazoo Lake and eventually terminates two miles downstream at Lake Michigan (Figures 11 and 12).

#### 2.2.12 Georgia-Pacific Corporation Kalamazoo Mill

The Georgia-Pacific Corporation Kalamazoo Mill, located on King Highway (Figure 14), was originally constructed and operated by the

Wolverine Paper Company until it was sold to the Kalamazoo Paper Company in 1899. Georgia-Pacific Corporation purchased the mill in 1967.

The original facility consisted of five mills: three paper mills and two coating mills. Mills 1, 2, and 3 were the paper mills, and Mills 4 and 5 were used for finishing and converting operations (Figure 14). Mill 2 was demolished in the 1980s. Mills 1 and 3 are currently active, while Mill 4 is used as a storage area.

The Kalamazoo Paper Company started deinking waste carbonless copy paper in the 1950s at Mills 1 and 3. PCBs first appeared in carbonless paper in 1957. Mill 1 stopped deinking in the late 1970s. Mill 3 stopped deinking in the late 1960s and resumed in 1975. Mill 2 was not a deinking mill.

The deinking process used before the 1960s at Mill 3 started with a conveyor and a pulper. The 11 chests used in the deinking process and the old floor drains were replaced with a new system in 1975.

In 1954, the Kalamazoo Paper Company constructed a 110-foot diameter clarifier for primary treatment of its process waste. Previously, all industrial wastewater from the mills was discharged to the Kalamazoo River, as was the standard practice at the time. During operation of the clarifier, wastewater flowed from the mills to a centrally located intercept station, which subsequently pumped the mill effluent to the clarifier. The clarified effluent (overflow) from the clarifier was directed to the Kalamazoo River, and underflow was pumped to the two adjacent lagoons. A clarifier and three lagoons located to the northwest of the plant were also used at this time to treat and dispose of wastewater from Mill 2 (1955, 1960, and 1967 aerial photographs).

The King Highway dewatering lagoons were constructed on the opposite side of the Kalamazoo River in the late 1950s for dewatering the underflow from the clarifier. The lagoons adjacent to the clarifier were subsequently used as emergency lagoons until 1980, when they were excavated and the material was taken to the King Highway Landfill. Currently, the area of the lagoons are partially backfilled with soil.

The former Hawthorne Paper Mill was located at the eastern edge of the mill property (Figure 14). Hawthorne Paper began manufacturing high grade bond, ledger, and printing paper in 1912, mainly from rag stock. Hawthorne's specialty was watermark paper (Kalamazoo Gazette, 1934b). The recycle stock was pre-consumer waste paper and did not require deinking. The Hawthorne Paper Company shut down in 1976 and the property was purchased by Georgia-Pacific in 1978. Shortly after the purchase, the mill was dismantled.

The former National Gypsum Company plant, located just south of Mill 4, is surrounded by Georgia-Pacific property (Figure 14). The company produced gypsum board liner until its closing in 1988. Presently, the former National Gypsum Company property is owned by Kalamazoo Township.

The Georgia-Pacific Corporation Kalamazoo Mill produces 400 tons per day of bond, offset, label, coated and recycled grades of paper (Lockwood-Post, 1991). The raw material used is comprised of 50 percent waste paper and 50 percent virgin pulp.

#### 2.2.13 Simpson Plainwell Paper Company Mill

The Simpson Plainwell Paper Company Mill (Figure 15) was founded by the Michigan Paper Company in 1886. Hamilton Paper purchased the mill

in 1956 and considered it their Michigan Division. Weyerhaeuser acquired the company in 1961 and operated the mill through the 1960s. Nicolet Paper Company was the owner during 1971 through 1975; it appears that the mill first became known as the Plainwell Paper Company during this time. The mill retained the name Plainwell Paper Company under ownership by Philip Morris Inc. and Philip Morris Industrial Inc. from the mid-1970s through 1984 (Pansini, 1990), and by Chesapeake Corporation in 1985. In late 1987, Simpson Paper Company purchased the mill and it became the Simpson Plainwell Paper Company Mill.

Deinking of waste paper prior to reuse of the wood pulp was practiced at the mill between 1910 and 1962 (Creal, 1987; RMT, 1990); PCBs apparently started appearing in waste carbonless copy paper in 1957. Deinking of office paper, which may have included PCB-containing carbonless copy paper, at the mill ended in 1962.

The deinking process, which occurred in the northwest corner of the facility, consisted of a single 16-foot diameter hydropulper where steam, a petroleum-based additive (to break up the inks), and hydrosulfite were added to a slurry of wastepaper. The pulp was then sent to inclined screen washers. In the late 1950s, the hydrosulfite was no longer used as a bleaching agent. It was replaced with hypochlorite, which was added at the bleach tower (tank reactor) that followed the first set of inclined washers. Another set of inclined washers followed the bleach tower.

The deinking area of the mill drained via a system of internal and external drains. This drainage system has since been reconfigured, and drains that were not taken out of service or removed now discharge through an open drain to the mill's wet well.

As was the standard practice at the time, wastewater was discharged directly into the Kalamazoo River until 1954, when a clarifier was installed adjacent to the mill and wastewater was treated by primary clarification. The clarified effluent was discharged into the Kalamazoo River. The underflow from the clarifier was dewatered in a series of on-site lagoons. Typically twice each year, each lagoon was excavated and the material was taken to the 12th Street Landfill.

In 1967, secondary treatment was initiated with the installation of a 1.85-million gallon plastic-lined aeration basin to the east of the lagoons and a secondary clarifier measuring 55 feet in diameter and 13 feet in depth located 500 feet east of the aeration basin (Thinnes, 1967). Effluent from the aeration basin was conveyed to the secondary clarifier. The effluent from the secondary clarifier was directed to the Kalamazoo River, and the underflow directed to the lagoons. Some biosludges produced in the aeration basin were excavated and taken to the 12th Street Landfill.

In 1981, a new primary clarifier was constructed and the old primary clarifier was subsequently torn down. A mechanical dewatering system (belt press), which produced a cake of 30 to 40 percent solids, also began operating in 1981. Consequently, the lagoons no longer received residuals.

Residuals produced from the mechanical dewatering system were disposed at commercial landfills. Residuals remaining in some of the lagoons were removed in 1981 and taken to the 12th Street Landfill. In 1983, the residuals from the rest of the lagoons were consolidated into four of the lagoons. These four lagoons are presently covered with soil and are well-vegetated. The other lagoons were filled with soil after being cleaned

out and are almost entirely located under the mill's present wastewater treatment facilities.

The secondary treatment system was updated in 1983 with the installation of a new secondary clarifier, and the old secondary clarifier was taken out of service. At this time, the aeration lagoon was also taken out of service and was replaced by an activated sludge treatment system (Lawton, 1987). The aeration basin was partially backfilled with construction and demolition waste. The activated sludge treatment system is in use today along with the primary and secondary clarifiers.

From a review of the historical aerial photographs of the mill area, it appears that in 1955, the primary clarifier and lagoons were in operation. A series of lagoons were located along the riverbank at the western end of the mill property (Figure 15); nine lagoons (lagoons A-I) are in a row with one lagoon to the west of the row (lagoon J). The historic aerial photographs show what appears to be an overflow discharge from the primary clarifier as part of its normal operation.

Two additional lagoons (lagoon K in the main row and lagoon L north of the row) are present in the 1960 aerial photograph and the primary clarifier appeared to be still operating.

The aeration basin and secondary clarifier are under construction in the 1967 aerial photograph. Lagoon L to the northwest of the row, visible in 1960, is not evident; however, two lagoons (M and N) were added to the row, making a total of 14 lagoons on-site, with one of them, lagoon L, no longer visible.

The 1974 aerial photograph indicates the aeration basin, secondary clarifier, and primary clarifier in operation and 13 lagoons are present.

However, lagoon J previously visible to the west of the main row is no longer visible, and the lagoon L to the north is now visible again.

The lagoons are no longer present in the 1991 aerial photograph. The original primary clarifier has been dismantled and its location is currently near a parking lot. The activated sludge tanks and current clarifiers are built where lagoons had once been located. The new primary clarifier is in operation, while the original secondary clarifier is not operating. A faint outline of three former lagoons is visible at the west end of the area, along with the former lagoon south of the row. The sludge dewatering facility, built in 1981, is also present.

Currently, the areas of the mill in which the deinking operation and its piping were located have been either refurbished or are no longer in use. The hydropulper, bleach tower, and stock chests used in the deinking process have been used at the mill for other purposes since deinking was terminated.

The mill produces coated and uncoated book and cover, release base, and technical specialty paper products. Production capacity is approximately 260 tons per day (Lockwood-Post, 1991). Additional information regarding this mill may be found in the DCS Report (Blasland & Bouck, 1992).

#### 2.2.14 Portage Paper Company Mill

The Portage Paper Company Mill (formerly the Allied Paper, Inc. Bryant Mills B, C, D, and E, and also known as the Performance Paper Mill) is located along Portage Creek in the city of Kalamazoo, approximately three miles upstream from Portage Creek's confluence with the Kalamazoo River.

During its 94 years of operation, the mill produced a variety of high-quality papers including bible, bond, uncoated book, end leaf, gift wrapping, label, map, offset, opaque, sensitizing, text, vellum, xerographic, litho, chart, music, and watermark paper. Production averaged 275 tons of product daily (Lockwood-Post, 1991). Raw materials used included both deinked recycled paper products and virgin pulp.

Historically, there were five operating mills (Mill A through Mill E). Waste paper was deinked and recycled at Mill A. From the late 1950s until 1971, carbonless copy paper apparently containing PCBs was included in the wastepaper stream and was deinked at the mill. The Mill A building was sold to American Pulp Corporation in 1972, then to Upgrade Company in the mid-1970s, and was demolished around 1978. A more thorough review of the historic wastewater treatment facilities at this mill is contained in the DCS Report.

As was the standard practice at the time, wastewater was discharged directly into the Kalamazoo River until 1954, when a clarifier was installed adjacent to the mill and wastewater was treated by primary clarification. The clarified effluent was discharged into the Kalamazoo River. The underflow from the clarifier was dewatered in a series of on-site lagoons.

The historic residuals dewatering lagoons (HRDLs) and the former Bryant Mill Pond area are part of the Allied Paper, Inc. OU and are addressed in a separate RI/FFS Work Plan.

#### 2.2.15 Former King Mill

The King Paper Company was founded by John King in 1901 as a one-machine mill at 1608 Lake Street in Kalamazoo (Figure 17). In 1922, the King Paper Company became Allied's King Division (Kalamazoo Gazette,

1934a). Deinking was performed at the mill until June 1965; it is unknown when deinking commenced at the King Mill (Figure 17). After June 1965, 100 percent virgin fiber was used (Oeming, 1965). The mill's main product was book printing material, which was generated at approximately 200 tons per day on four paper machines in the late 1960s.

Until 1955, prior to the appearance of PCBs in carbonless copy paper, in accordance with the standard practice at the time, untreated effluent was conveyed to the Kalamazoo River (Oeming, 1954). After 1955, the waste treatment for the mill consisted of save-alls for each of four paper machines and a 110-foot diameter clarifier. A large portion of the clarified effluent was reused in the paper-making process (MWRC, 1968). The remainder was conveyed via a concrete culvert which discharged to the Kalamazoo River adjacent to the King Street storm sewer outfall, according to city sewer maps.

Residuals produced from mill operations were dewatered and disposed at the A-Site. Also, some residuals were evidently disposed in one or two on-site lagoons (Figure 17).

In the 1955 aerial photographs, it appears that the 110-foot diameter clarifier (clarifier A) was under construction. There also appears to be an elongated lagoon running north-south just east of the mill. The area does not appear to have defined berms, but appears to be more of a shallow excavation.

The 110-foot diameter clarifier appears to be operating in the 1960 aerial photographs and there is evidence that the north-south running lagoon has piles of material within its boundary. There is also evidence of a disturbed area to the northeast of the lagoon.

In the 1967 aerial photographs, the elongated north-south running lagoon appears to be filled and vegetation was encroaching into the lagoon. The lagoon to the northeast has defined berms which appear vegetated. This lagoon contains fill material and what appears to be ponded water. The 110-foot diameter clarifier appears full with wastewater. To the southeast of the clarifier, a new, smaller diameter clarifier (clarifier B in Figure 17) is under construction.

In the 1974 aerial photograph, the elongated north-south running lagoon is filled and vegetated. The lagoon to the northeast is still visible; however, it appears that vegetation is encroaching into the lagoon. The 110-foot diameter clarifier has been removed and the smaller clarifier appears to be operating.

The mill was sold by Allied in 1971 to Arthur Dore of the Dore Wrecking Company, presently Dore Enterprises. After fires had damaged the mill in 1975 and 1976, Dore completed demolition of the mill in December 1978 (Hager, 1979). Further information may be found in the DCS Report.

#### 2.2.16 Former Monarch Mill Property

The Monarch Mill (Figure 18), originally the Kalamazoo Paper Company Mill, was built in 1867 on Cork Street. In 1872 it was rebuilt out of brick after the original building was destroyed by fire. The building was sold to Gibson Paper Company in 1899, and then to the Monarch Paper Company in 1906 (Troyer, 1957). It became the Allied Paper, Inc. Monarch Mill in 1922.

Until the early 1950s, in accordance with the standard practice at the time, wastewater was discharged directly into Portage Creek. In the 1950's,

Allied constructed a primary treatment facility for the Monarch Mill to meet acceptable discharge limits of biochemical oxygen demand (BOD) and suspended solids (SS). Allied was the first paper mill in the area to have such a proposal accepted by the MWRC. Allied installed a clarifier and established residuals dewatering and storage lagoons. The clarifier was used by the Bryant Mill when it was acquired by Allied.

The Monarch Mill produced carbon tissue and book printing paper, using both bleached and unbleached kraft, and deinked stock (MWRC, 1967). As of 1965, the mill was using 100 percent virgin fiber (Oeming, 1965). In December 1980, the Monarch Mill was closed and subsequently razed (MDNR, 1984a).

#### 2.2.17 King Street Storm Sewer

The King Street Storm Sewer outfall is located in the city of Kalamazoo just north of the intersection of King Highway and the former Grand Trunk Western Railroad easement, adjacent to the northwest section of the King Highway Landfill OU (Figure 19). The outfall is situated in the Kalamazoo River floodplain within a predominately industrial setting. More historical information regarding the King Street Storm Sewer is located in Section 2.2.15.

### **SECTION 3 - INITIAL SITE EVALUATION**

#### **3.1 Types and Volumes of Materials Present**

The presence of PCBs in the Kalamazoo River has been the subject of a number of studies since 1971. These studies, which have been documented in the DCS Report, have produced a database sufficient for an initial assessment. Summaries from this database regarding the presence of PCBs in sediments, water column, and fish of the Kalamazoo River and Portage Creek are presented in Tables 2-2, 2-3, and 2-4, respectively.

Although a significant database has been generated related to the NPL Site, sufficient data are not presently available to satisfy the objectives specified in Section 1.2. Consequently, this RI is designed to provide sufficient data, utilizing historical and new data, to meet these objectives. The specific work tasks described in Section 5 were designed to fill gaps of knowledge of NPL Site conditions consistent with established guidance by USEPA (1988a) and additional guidance pursuant to Act 307.

#### **3.2 Identification of Potential Chemical Migration Pathways and Potential Public Health and Environmental Impacts**

##### **3.2.1 Identification of Potential Chemical Migration Pathways**

Preliminary descriptions of the concentration and distribution of PCBs in environmental media are provided in the DCS Report. The Site characterizations presented in the referenced document allow for a preliminary evaluation of the potential for chemical migration. A discussion of the environmental fate and transport properties of PCBs is also presented in the DCS Report.

PCB migration within the NPL Site depends primarily upon river-based transport. Dissolved-phase or suspended-phase transport may occur in the water column. PCBs present in exposed sediments in the former impounded areas are potentially reintroduced into the Kalamazoo River during episodes of high flow or as a result of surface runoff. In addition, PCBs in suspended sediments are potentially deposited on floodplain soils during periods of high flow and flooding events. Additional potential pathways include transfer of PCBs from the water column, near-surface sediment, and the exposed former impoundment sediment to aquatic and terrestrial biota.

Although there are some indications that the Kalamazoo River may recharge some aquifers in the area, preliminary evaluations suggest that shallow groundwater and surface water flow patterns are toward the Kalamazoo River or Portage Creek. To confirm this preliminary evaluation, the RI will investigate groundwater and surface flow patterns in select areas of the NPL Site.

In areas where concentrations of PCBs have been detected in exposed floodplain soils or sediments (i.e., former impounded areas), wind-blown dust containing PCBs, rather than PCB volatilization is "the most likely potential pathway for airborne transport of PCBs", according to the Agency for Toxic Substances and Disease Registry (ATSDR 1991). PCBs have a low vapor pressure and hence a low tendency to volatilize from dry surfaces. However, theory and measurements from other sites predict some volatilization of the expected low concentrations of dissolved PCBs in the Kalamazoo River.

Any potentially significant contribution of constituents of interest to the Kalamazoo River and Portage Creek from paper mills (previously and currently in operation) may occur from stormwater and process water discharges. The RI will investigate paper mill stormwater conveyances for PCBs, PCDDs, and PCDFs. Mill process water discharges are monitored under separate regulatory programs and will not be sampled.

### 3.2.2 Potential Public Health and Environmental Impacts

#### 3.2.2.1 Public Health Issues

Issues of public health stem from the potential toxicity of PCBs and the potential for receptor groups to become exposed to PCBs through normal activities. Potential PCB toxicity is discussed in the DCS. Potential receptor populations, and the conditions/activities promoting exposure to PCB-containing media are also discussed in the DCS Report. A brief summary of the DCS is presented below.

#### 3.2.2.2 Potential Exposure Pathways

Land use in the vicinity of the NPL Site varies extensively. The Kalamazoo River, Portage Creek, and other associated NPL Site areas are bordered by a variety of land uses including urban, agricultural, suburban and rural residential, and developed/undeveloped recreational areas. Portions of the NPL Site are secured against unauthorized access. The four receptor groups identified at the NPL Site include occupationally-exposed individuals, recreationists, residents, and trespassers.

The following evaluations describe potential exposure pathways for the receptor groups. In general, direct dermal contact, inhalation of airborne particles, ingestion of groundwater, and incidental ingestion

of soils, sediments, and surface waters containing PCBs are potential routes of exposure.

#### Occupationally-Exposed Individuals

This group of receptors includes all maintenance personnel who have access to portions of the NPL Site, including production/maintenance employees who work for any commercial/industrial firm which maintain an impoundment or water intake on the Kalamazoo River. Employees of industries using Kalamazoo River water for production purposes may have dermal contact/incidental ingestion exposure to the production water. Maintenance activities in association with the upkeep of intake facilities on the Kalamazoo River potentially results in exposure to sediments. Other potential exposure pathways include groundwater and airborne particulates.

#### Recreationists

Individuals pursuing recreational activities on or in proximity to the Kalamazoo River or Portage Creek represent a diverse receptor group. Anglers and boaters may be exposed to surface water and sediments. Trappers and hunters may also be exposed to surface water and sediments, in addition to stream bank/floodplain soils. Some anglers may ignore the consumption advisory on Kalamazoo River/Portage Creek fish and consume their catch. It has also been reported that turtles have been taken from the River for human consumption.

Picnickers, hikers, and individuals pursuing other pedestrian-based activities on public or private lands adjacent to the Kalamazoo River

or Portage Creek also have the potential to experience dermal contact/incidental ingestion exposure to floodplain soils.

#### Residents

Normal daily activities in residential areas will not result in exposure to surface waters and sediments of the Kalamazoo River and Portage Creek. Inhalation exposure to airborne particulates originating from floodplain soils is a possible exposure pathway although these areas are not prone to wind erosion due to dense vegetative cover in most areas and the moist, cohesive nature of the remaining unvegetated areas. To the extent that residents may be exposed to PCBs in certain floodplain soils, this potential exposure pathway will be addressed based upon the findings of the RI.

As part of this RI, water wells within one-half mile of Portage Creek and Kalamazoo River will be summarized and assessed for potential impacts by PCBs in groundwater.

#### Trespassers

Various sections of the Kalamazoo River and certain sections of Portage Creek are accessible to the public; however, areas also exist where unauthorized access is denied through the use of fencing, posted signs, or other means. Although the presence of such structures would generally pose barriers to trespassers, it is standard practice in analyzing such situations to assume that trespass by unauthorized pedestrians is occurring. In the unlikely event that this pedestrian trespass does occur, it is reasonable to assume that the related exposure scenarios for this receptor population would be

identical to those associated with recreational use of these areas which are described above.

Potential human health impacts will be investigated and discussed in the human health risk assessment being prepared by MDNR.

#### 3.2.2.3 Potential Environmental Impacts

Aquatic biota of the Kalamazoo River and Portage Creek and other wildlife that live in proximity to the Kalamazoo River are potentially subject to PCB exposure or accumulation through contact with surface water, sediment, and soil or through the food chain. Potential environmental impacts will be investigated and discussed in the ecological risk assessment being prepared by MDNR.

### 3.3 Preliminary Identification of Response Objectives and Remedial Alternatives

The primary objective of this phase of the RI/FS is to identify potential response objectives for each affected medium and a preliminary range of remedial alternatives and associated technologies. This task is intended to be a general classification of potential remedial objectives and alternatives based upon the potential chemical migration pathways and potential public health and environmental impacts. Preliminary response objectives and ARARs will be identified by Blasland & Bouck to assess the applicability of remedial technologies to the NPL Site.

Data required to gauge the feasibility and effectiveness of preliminary identified technologies (see Section 6) have been considered in the design of the RI.

## **SECTION 4 - WORK PLAN RATIONALE**

### **4.1 Identification of Data Needs**

To meet the objectives of the RI/FS, data produced by the previous investigations of the NPL Site (pending quality assurance review) will be supplemented by additional data which will be collected to characterize materials and constituent transport at the NPL Site and to support the evaluation of remedial alternatives.

Data needs, in general, arise from the necessity to evaluate the horizontal and vertical extent of constituents of interest and to determine potential sources, migration pathways, and fate. This information will be used in preparing exposure assessments and in developing remedial alternatives. The rest of this section will briefly outline anticipated data needs.

A plan entitled "Quality Assurance/Quality Control Review of Historical Studies and Data Plan" (QA/QC-RHSDP) has been developed for the NPL Site and other areas being investigated in the RI in order to provide for a quality assurance/quality control (QA/QC) review of historical data for qualification and use in the RI/FS (Blasland & Bouck, 1993e). Upon QA/QC review of this information, written approval will be solicited from MDNR to allow incorporation of qualified data sets into the RI/FS.

Existing water-column data applies to previous conditions in Portage Creek and the Kalamazoo River. The current conditions need to be documented in order to determine both temporal trends and constituent transport behavior in the water column. It is also necessary to collect water-quality data during high flow events in order to characterize any erosional transport of sediments that may

contain constituents. Water-column sampling and analysis are proposed for Portage Creek and the Kalamazoo River.

Sediment samples are necessary to characterize the extent and potential bioavailability of constituents. PCBs will remain the primary investigation focus, although selected samples will be screened for CLP TCL/TAL constituents as per the direction of MDNR.

In 1988, MDNR collected 282 sediment cores at surveyed locations in its former Plainwell, Otsego, and Trowbridge impoundments along the Kalamazoo River. Soil lithology of all of the cores was described; however, only 19 cores were analyzed for PCBs. A relationship between PCB concentration and soil texture, such that texture could be used to predict either the concentration or presence of PCBs, could not be established. In this Work Plan, further analyses will be conducted to characterize the sediments and the areal distribution of PCBs in the floodplain of the former impoundments.

Since fish consumption is a potentially significant route of human and wildlife exposure to PCBs from the Kalamazoo River and Portage Creek, establishment of current PCB concentrations in fish is necessary to support the EA. Sampling will also be used to assess trends and gradients in PCB concentrations in fish.

Geotechnical information including physical characteristics of Kalamazoo River sediment and exposed former impoundment sediment will also be collected to support the evaluation of remedial alternatives.

More complete discussion of the rationale for sample collection is provided within Section 5.

#### **4.2 Work Plan Approach**

The RI/FS will be conducted in accordance with the requirements of CERCLA, NCP, and Act 307, and will follow approaches provided in the guidance pursuant to these laws. The considerable body of existing information regarding the NPL Site (Blasland & Bouck, 1992) has been used to establish certain premises for proceeding efficiently with the RI/FS.

##### **4.2.1 Constituents of Interest**

PCBs are the constituents of interest at the NPL Site. The scoring packet which was used to justify the inclusion of the NPL Site on the NPL identified PCBs exclusively as the constituent of concern (MDNR, 1989a). The ATSDR Preliminary Health Assessment for the NPL Site (1991) also addressed only PCBs as the principal constituent of interest.

Although the Work Plan is premised upon the hypothesis that PCBs are the only constituent of interest at the NPL Site, MDNR requires that the KRSG analyze samples of environmental media from various areas for a full array of other chemical constituents (i.e., volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), pesticides/PCBs, PCDDs, PCDFs, and inorganic compounds) to test that hypothesis. The CLP TCL/TAL constituents are listed in Table 4-1. PCDDs and PCDFs are listed in Table 4-2.

##### **4.2.2 Surface Water Pathway**

The Work Plan proposes an ambitious surface water sampling program to characterize PCB transport in the Kalamazoo River and Portage Creek under different flow regimes. The focus of these activities is to understand the mechanism of PCB transport and quantify PCB transport for Portage

Creek and the Kalamazoo River. In addition, a number of samples will be analyzed for constituents on the CLP TCL/TAL.

#### 4.2.3 Biota Pathway

The predominant route of potential human exposure to PCBs from the NPL Site is expected to be the consumption of fish and possibly turtles. The approach adopted for the collection and analysis of biota focuses on species representative of those potentially consumed by humans. The EA will be based, in part, on fish and other biota (i.e., small mammals, earthworms). The MDNR has prepared a draft Biota Sampling Plan (Camp Dresser & McKee, 1993) to support the EA for the Site.

#### 4.2.4 Sediment and Floodplain Soils Pathway

The floodplain soils and sediment investigation outlined in the Work Plan is designed to:

- Characterize sediments to determine candidate sampling sites for a second phase which will define the distribution of PCBs in river sediments;
- Define the areal and vertical extent of PCBs in floodplain soils and exposed former impoundment sediments (similar to the surface water investigation, a number of floodplain soil samples will also be analyzed to screen for the presence of other chemical constituents in addition to PCBs);
- Identify source areas of PCBs;
- Assist in the evaluation of remedial alternatives; and
- Evaluate levels of risk to the environment and human health posed by PCBs in sediments and floodplain soils.

#### 4.2.5 Identified and Potential Source Areas

Several activities, including water-column monitoring, sediment investigations, and special studies of source areas, will address PCB contributions from potential sources upstream of and along the NPL Site. Investigations will include the Portage Paper Mill property, the Simpson Plainwell Paper Company Mill property, and the Georgia-Pacific Corporation Kalamazoo Mill property along with those additional areas described in Section 2.3.1, to assess whether these areas may be functioning as sources of PCBs to Portage Creek and the Kalamazoo River. The investigation will provide the data to evaluate risks to the human health and the environment posed by PCBs in sediments and floodplains. In light of the environmental behavior of PCBs, these investigations will focus on any identified surface water migration pathways (e.g., surface drainage, process discharges, or other unmonitored discharges), as any PCB transport will most likely be due to the movement of PCBs sorbed to soil or sediment movement via surface water/pipe flow.

#### 4.2.6 Baseline EA

In accordance with the AOC, the baseline EA is the responsibility of MDNR. As the lead agency for this Site, MDNR and their contractor will conduct the EA although Blasland & Bouck will produce much of the data that will be used for the EA.

### 4.3 Data Quality Objectives

Data quality objectives (DQOs) are specified to ensure that the analytical data generated during the RI are adequate to support the objectives of the RI/FS. The DQOs are statements that specify the objectives of the activity, the

data quality required, and the appropriate analytical procedure to achieve the objective. Data quality objectives are summarized in Tables 4-3 and 4-4.

The CLP TCL/TAL analytical data will be used to characterize the potential sources, distribution, and migration pathways of the quantifiable constituents. The TCL includes VOCs, SVOCs, PCBs, and pesticides. The TAL includes inorganic constituents. Table 4-1 provides a list of constituents on the CLP TCL/TAL. PCDDs and PCDFs may be found on Table 4-2. Because these data will be used to assess the potential risks and to determine the necessity of remedial alternatives, analytical methods to be used include those that conform to CLP Statements of Work (SOWs).

### **5.3 Plans and Management**

The AOC requires the preparation of a series of plans to manage and implement the RI. These plans, as well as others required by MDNR for the OUs, are listed below and have been submitted under separate cover:

- RI/FS Work Plan and Field Sampling Plan (FSP);
- RI/FFS Work Plans and Field Sampling Plans for the Allied Paper, Inc. OU, Willow Boulevard/A-Site OU, King Highway Landfill OU, and 12th Street Landfill OU;
- Quality Assurance/Quality Control Review of Historical Studies and Data Plan (QA/QC - RHSDP);
- Data Management Plan (DMP);
- Quality Assurance Project Plan (QAPP);
- Health and Safety Plan (HSP);
- Community Relations Plan;
- Plan for Satisfaction of Permitting Requirements; and
- ATSDR Health Assessment.

The work plans describe in detail the field investigation activities to be conducted. This includes a statement of sampling objectives, specification of equipment, laboratory analyses to be performed, the types of samples which will be collected, sampling locations and frequency, and schedule. An initial work plan was submitted on March 27, 1991, and a revision submitted on February 15, 1993. The specific OU RI/FFS Work Plans and FSPs were submitted to MDNR on February 4, 1993.

The FSPs describe the procedures and equipment to be used for field data collection, including sample collection and sample processing, and cite the analytical methods to be utilized. These documents provide instructions for field

The Plan for Satisfaction of Permitting Requirements defines the way that permitting issues, which may arise during the RI/FS, will be addressed. This plan was submitted to MDNR on February 4, 1993 and a revision submitted on June 16, 1993 (Blasland & Bouck, 1993f). The ATSDR Health Assessment was completed in 1991 (ATSDR, 1991).

#### **5.4 Site Investigations**

The AOC requires that the RI/FS Work Plan outline RI activities to satisfy the goals and objectives listed in Section 1.2.

As previously discussed, in order to meet the objectives of the RI/FS, previous NPL Site data will be qualified and the data gaps will be satisfied by the various field investigations. During the RI, QA/QC samples will be collected and analyzed as prescribed in the QAPP (Blasland & Bouck, 1993a).

Although specific sample collection intervals may be identified, stained/discolored soils, odorous soils, or soils with other distinguishing characteristics will not be composited with cores above or below the distinguishing change.

##### **5.4.1 Sediment and Floodplain Soils Investigations**

###### **5.4.1.1 Introduction**

In 1971, PCBs were reported in resident fish of the Kalamazoo River (Hesse and Wilson, 1972). Further investigations identified the presence of PCBs within the surface water and sediments of both the Kalamazoo River and Portage Creek. Details regarding the previous investigations are discussed in the DCS Report (Blasland & Bouck, 1992). A summary of recent data is presented in Tables 2-2, 2-3, and 2-4.

Previous studies, which focused attention on the presence of PCBs in the Kalamazoo River system, need to be supplemented by additional information to satisfy the RI/FS objectives of the AOC as re-stated in Section 1.2.

Issues which will be further assessed by the RI include:

- The distribution of PCBs in sediments within the NPL Site upstream of the Lake Allegan Dam;
- The distribution of PCBs in the exposed sediments of the former Plainwell, Otsego, and Trowbridge Impoundments;
- The potential significance of transport of PCBs from the Kalamazoo River and Portage Creek to the floodplain during flood events; and
- The potential significance of other constituents which may be present in NPL Site sediments or floodplain soils.

In the course of addressing these issues, data will be generated which will also be used to assess:

- The relative contribution and significance of various PCB sources to the Kalamazoo River;
- The nature of deposition downstream of Lake Allegan and the history of PCB transport in the Kalamazoo River;
- Spatial gradients in surficial-sediment PCB concentrations including relative gradients in bioavailable PCB concentrations; and
- The extent of PCB biodegradation (anaerobic dechlorination) in Portage Creek and the Kalamazoo River.

Two different approaches to assessing the distribution of PCBs in Kalamazoo River sediment will be evaluated in the initial phase of the investigation: a stratified sampling approach; and a geostatistical approach. The initial phase of sediment investigation, which includes a physical characterization survey and a geostatistical sampling pilot study, will provide the basis for determining the approach to the subsequent phase of sampling to define the distribution of PCBs in Kalamazoo River sediments.

The stratified approach to sampling sediment and floodplain soils is based upon established principles regarding sediment and hydrophobic constituent transport and deposition in rivers which predict a general relationship between flow velocity and deposition of PCBs with fine-grain sediments. This relationship is such that the highest sediment PCB concentrations (as well as other hydrophobic constituents) are expected to be found in low-energy zones within the Kalamazoo River and Portage Creek where fine-grained sediments accumulate. To define this relationship, an intensive in-stream sediment probing survey will be performed to determine the character of sediments in each of the nine segments (described in Section 2.2) of the Kalamazoo River and Portage Creek. These separate segments were divided based on the hydraulic and hydrologic variations in the Kalamazoo River and Portage Creek. Activities to be performed in these segments are discussed later in this section.

The proposed sediment characterization activities will involve the probing and sampling of sediments to be classified according to observed differences in grain-size and sediment texture. Results,

including sediment mapping, from this initial sediment survey will be used to recommend locations for subsequent (Phase II) sediment-core sampling for PCBs and total organic carbon (TOC) using a stratified approach.

As directed by MDNR, a geostatistical sampling pilot study will be conducted to assess the feasibility of using a geostatistical approach as an alternative to a stratified sampling approach to the assessment of the sediment PCB distribution in the Kalamazoo River. The geostatistical sampling pilot study will be an intensive sediment sampling program in a 1-mile section of the River to analyze systematically relationships between the difference of paired sediment sample PCB concentrations and the distance separating the sample pairs. This spatial relationship is illustrated as a semivariogram, a fundamental tool of geostatistics upon which other procedures, such as kriging, rely.

The initial phase of sediment characterization, which includes the physical characterization survey and the geostatistical sampling pilot study, will provide the basis for determining the approach to the subsequent phase of sampling to define the distribution of PCBs in the Kalamazoo River sediment.

The investigation of exposed former impoundment sediments, as well as select areas of the Kalamazoo River floodplain, will include efforts to characterize the presence and extent of PCBs and to screen for other CLP TCL/TAL parameters. Samples of floodplain soil and exposed former impoundment sediments will also be collected and analyzed to characterize the exposure of selected terrestrial

invertebrates and small mammal specimens, which will be collected as part of the Biota Sampling Plan (Camp Dresser & McKee, Inc., 1993).

Blasland & Bouck proposes to use PCB immunoassay test kits for selected tasks within the Kalamazoo River Site Work Plan. The test kits will be used for soil screening on an as needed basis, particularly for defining the extent of PCBs present. Standard concentrations for the soil screening will be 1 ppm and 20 ppm. The specific methodology for use of the immunoassay field kits has been included in Appendix Q of the QAPP. Specific tasks which will involve the use of the immunoassay kits are identified in the following sub-sections.

Reference sediment (Phase II) and floodplain soil samples will be collected upstream of the NPL Site in Morrow Lake and the Fort Custer Recreation Area. The sampling plan pursuant to the proposed activities are discussed below and is summarized on Table 5-1.

#### 5.4.1.2 Sediment Investigation - Stratified Sampling Approach

##### Rationale

The use of stratified sampling approaches for chemically characterizing sediments is commonly used in the investigation of contaminated sediment sites in the United States and specifically in the Great Lakes region. Protocols and guidance developed by the International Joint Commission (IJC, 1988) and USEPA's Assessment and Remediation of Contaminated Sediments (USEPA, 1991a) program to investigate contaminated sediments in Great Lakes Areas of Concern embrace this approach. Large Superfund sites where PCBs are the constituent of interest and which are presently in the RI/FS process, including the Hudson River in New York and the Sheboygan River in

Wisconsin, are using this approach. Other major government initiatives, such as the development of a sediment-management demonstration project on the Fox River in Wisconsin, have also used the same approach.

The stratified sampling approach to river sediment is built upon an understanding of:

- The nature of hydrophobic chemical transport in rivers and lakes;
- Pathways involved in the principal risks to humans and the environment at aquatic and semiaquatic PCB sites; and
- Remedial alternatives for such sites and the process of their development and evaluation.

Notwithstanding historical data QA/QC issues specific to the NPL Site, much is already known about the nature of the PCBs in the Kalamazoo River from the large amount of information that exists on this Site and similar sites. PCBs, due to their hydrophobic nature, have an affinity for organic particles. Due to the low-density of organic particles and the relationships of particle size to settling velocity for inorganic sediments, one expects to find the highest PCB concentrations in low-energy areas where fine-grained and organic sediments deposit. One would expect that the bulk PCB concentrations in surficial sediment (i.e., ratio of mass of PCBs to mass of sediment) are higher in the areas of fine-grained sediment than in areas of coarse sediment. However, expressed on a basis relevant to chemical equilibrium with the overlying water column (e.g., normalized per unit of organic carbon), it is expected that PCB concentrations in coarse surficial sediment are more comparable to those found at the surface of

fine-grained sediment deposits. This subtle aspect will have some bearing on the development and evaluation of remedial alternatives in terms of long-term and short-term effectiveness.

Consumption of fish is usually the pathway associated with potential human PCB exposure at aquatic PCB sites similar to the Kalamazoo River. Fish are a mobile media which, in the Kalamazoo River and Portage Creek, are expected to integrate exposure to constituents in sediment on spatial scales of thousands of feet. The extent of bioaccumulation in fish is a function of the properties of the receptor organism (e.g., trophic niche, capacity for metabolism, fat content), the ecosystem, and the specific PCB compounds present. Other pathways that will need to be addressed in the EA include, but are not limited to, direct contact with soil and sediment. Individual exposure rates to PCBs via these pathways will be less than the estimates of individual PCB exposure via fish consumption. Consequently, it will be important to collect data which can elucidate the relationship between constituent sources (e.g., sediment), and chemical bioaccumulation in fish. Towards this end, the sediment investigations will be complemented by investigations of PCB transport in the water column as well as monitoring of PCB levels in fish.

A general understanding of the factors affecting PCB levels in fish will be necessary to understand the nature of potential human exposure to PCBs at the NPL Site and to evaluate the ability to reduce that exposure through remedial alternatives. Although some appreciation for the fine-scale features of the Kalamazoo River will be helpful, the overall analyses should be conducted on a large (segment-by-segment) scale.

important aspects of the evaluation and that they are most appropriately addressed on large scales for a site such as the NPL Site.

The stratified sampling approach to defining the nature and extent of contamination is consistent with the goals of the AOC, USEPA guidance on sediment sampling, and sediment sampling programs successfully conducted at a number of similar sites. The approach incorporates known aspects of PCB transport and deposition in river systems and the relationship between PCBs and fine-grained or organic sediments in a stratified design. As discussed in USEPA's "Sediment Sampling Quality Assurance Users Guide" (Barth and Starks, 1985):

"Stratification is a sampling procedure for improving the precision of estimates. This technique makes use of scientific knowledge that the measurement may be quite different in different identifiable segments of the area being sampled. A typical stratification criterion used in soil science is soil type. Another criterion that might be useful in sediment sampling is distance from point source of pollutants."

The proposed sampling design draws upon the criteria presented in the USEPA guidance. Because of the known association of PCBs with fine-grained sediments, the sampling program will focus on the extent and PCB content within these types of deposits. In recognition of the hydrologic differences along the Portage Creek and Kalamazoo River to be studied and different distances from the original sources, the NPL Site has been divided into nine segments for study (Section 2.2.1).

An initial intensive in-stream sediment probing survey is proposed to determine the extent, volume, and characteristics of sediments in each segment. Results from probing activities will be used to determine

sediment core locations for PCB analysis in a second phase. The value of this approach is well recognized:

"Given the costs of sampling and of laboratory analyses, it is prudent to conduct some cursory field studies before developing the sampling and analysis plan. Such studies should be mandatory where any existing physical information is lacking. The amount of time and money that can be saved by simply visiting the site in a small boat and poking a long stick in the mud cannot be overestimated" (USEPA, 1991d).

Using the knowledge gained from the sediment probing survey and previous experiences at a number of other similar sites, fewer well-placed sampling locations can be selected to provide the same detail and accuracy of estimation as a more dense, regular grid sampling network (Baudo, 1990).

Hakanson (1984) demonstrated the increase in statistical information value obtained by the recognition of factors, such as particle-size distribution and organic carbon content, which contribute to the variability of hydrophobic chemical concentrations in sediments. The increase in statistical value was illustrated in a dramatic reduction in the number of sediment samples required to provide an estimate of means at a given confidence level. The proposed sampling program takes this into consideration and therefore includes provisions in the second phase for the collection of data such as percentage of silts and clays and TOC content. By normalizing PCB concentration to these factors, the random variability is expected to be reduced, providing for greater statistical power and, more importantly, better understanding of PCB distribution within the sediments.

### Methods

An intensive in-stream sediment probing survey will be conducted to provide information related to present-day conditions as well as a broad understanding of the river flow dynamics and the effects of these dynamics on in-stream sedimentation patterns. A thorough field study to assess the distribution of present-day fine-grained sediment depositional areas will be performed. During the generalized mapping, available ancillary information which would indicate the presence of low velocity, deposition areas, such as channel morphology and aquatic vegetation will be noted. Identification of areas of fine-grained deposits will be based on the results of points probed and noted ancillary information. The sediment texture classes included as primary visual descriptions on the Unified Soil Classification System (Kirkham, 1964) are fine-grained, coarse-grained, and organic. For the purpose of this investigation "fine-grained" will include both fine-grained and organic sediment.

Sediment probing activities will be conducted in each of the following segments of the Kalamazoo River:

- Davis Creek Confluence to Main Street, Plainwell;
- Main Street, Plainwell to the Plainwell Dam;
- Plainwell Dam to the Otsego City Dam;
- Otsego City Dam to the Otsego Dam;
- Otsego Dam to the Trowbridge Dam;
- Trowbridge Dam to the Allegan City Line;
- Allegan City Line to the Allegan City Dam;
- Allegan City Dam to the Lake Allegan Dam; and
- Lake Allegan Dam to Lake Michigan.

The segment of Portage Creek from Alcott Street to the Kalamazoo River confluence will also be probed. The probing and sampling of Portage Creek between Alcott Street and Cork Street is described in the Allied Paper, Inc., OU RI/FFS Work Plan. The number of transects anticipated in each segment is summarized in Table 5-1. The approximate locations of these transects are illustrated in Figures 4 through 10.

Within each of the nine segments, transects will be spaced at approximately equal distances apart; however, the distance between transects will vary among segments depending on the segment length. Along each transect, an average of six to eight equidistant points will be probed using metal rods and hand-coring equipment. The number of points within a transect may be slightly lower for the segment in Portage Creek due to its smaller width. The metal rod will be pushed to refusal and the depth penetrated will be recorded. Clear Lexan® tubes will be used to obtain a core sample for visual inspection. In addition, pending MDNR acceptance of preservation of sediment samples by freezing for PCB analysis, as described in the June 16, 1993 QAPP, cores will be retained at approximately 700 locations for possible PCB analysis. Photographs will be taken of all core samples retained. Further information regarding the procedures, methods, and equipment to be utilized for sampling are contained in the FSP.

In those segments with impoundments, several transects will be positioned within the current impounded area. These transects will be treated similar to transects which occur in the Kalamazoo River channel; however, because of the greater distance between probing points along the transects (i.e., same number of sampling points along longer transect), a

weighting factor may be applied in subsequent volumetric analyses. This weighting factor will be proportional to the greater sediment bed surface area represented by each probed location as distance between points becomes greater.

At each of the approximately 72 to 208 sediment probing points per segment the following information will be obtained and recorded:

- location;
- depth of sediment (refusal of probe);
- depth of water;
- grain-size characterization (fine-grained vs. coarse-grained);
- secondary sediment descriptions (e.g., color, presence of debris, types of coarse material, or paper residuals);
- water velocity at 0.6 times the depth at 20 to 25 percent of transects;
- Kalamazoo River and Portage Creek physical features; and
- other appropriate field conditions and observations.

The upper four inches of cores will be collected, cataloged, and retained for possible future physical property analyses.

In addition to the raw data, the intensive sediment probing survey will provide an estimate of the areal extent of fine-grained sediments in each reach. For the purposes of statistical analysis, the characterization of sediments as either fine-grained or coarse-grained can be treated as a binomial distribution. With the projected number of probing determinations per stretch the standard deviation of the estimated area of fine-grained material should fall within the  $\pm 3$  to 4 percent range. Combining the grain-size characterization results with sediment depth data, the volume of

fine-grained and coarse-grained sediments for each stretch can be estimated.

Data obtained during the sediment probing will be used to develop generalized maps illustrating depth and characteristics of sediment deposits. Ancillary information such as channel depth, velocity, and geometry will be reviewed and related to depositional characteristics. This information, in particular the generalized maps, will be used to recommend a Phase II stratified sampling approach for estimating PCB concentrations and PCB mass within fine-grained and coarse-grained sediment in each reach. The information gathered during the sediment probing survey may also be used for other purposes in the future. The cross-sectional profiles and water velocities may be used in developing and calibrating hydrodynamic models (if appropriate) for the Kalamazoo River. Similarly, archived surficial sediment samples may be analyzed for physical properties to support possible applications of sediment-transport or water-quality transport models, if appropriate.

#### 5.4.1.3 Sediment Investigation - Geostatistical Approach

##### Rationale

At the direction of MDNR, a pilot study will be conducted as part of the RI activities to assess the feasibility of using a geostatistical approach to the characterization of sediment-related PCB deposition within the Kalamazoo River. The geostatistical software package Geostatistical Environmental Assessment Software (GeoEAS) (Englund and Sparks, 1988) developed by the USEPA's Environmental Systems Monitoring Laboratory (ESML) will be applied to the data collected as part of this pilot study.

Geostatistical studies frequently use a multiphase approach with the first sampling phase being oriented primarily towards estimating the spatial relationship between distance and variability. This spatial relationship can be expressed as a semivariogram, the fundamental tool of geostatistics. Because the initial estimation of the spatial correlation plays such an essential role in subsequent geostatistically-based procedures, such as sampling network design or mapping results, special attention is spent in the initial phase of a geostatistical study.

The secondary sampling phase of the geostatistical study has the goal of covering an area with sufficient sample points to contour the data value within an acceptable error of interpolation. The sample spacing is determined by using the information from the semivariogram to determine the orientation, shape, and size of the sample grid spacing (Flatman et al., 1988).

Kriging can then be used to map the data. Kriging is a linear-weighted averaging technique used in geostatistics to estimate unknown points from surrounding data with the smallest possible error variance for the estimate. The variance of the estimate is minimized by assuming the same spatial correlation for the unknown points as for the known data set.

### Methods

A 1-mile reach of the Kalamazoo River upstream of the former Trowbridge Dam (Figures 8 and 20) has been selected as the Site for the Geostatistical Sampling Pilot Study. This segment has been selected because it contains both straight and meandering sections

The location, depth of water, depth of core, and a lithologic description will be noted for all cores. Samples for analysis of PCBs will be taken from the upper one-foot interval and lowest one-foot interval above any identifiable residual/native soil interface of each core. If no interface is identifiable the sample will be taken from the lowest one-foot interval of the core. As directed by MDNR, photographs will be taken of each core sample.

PCB data collected during the geostatistical pilot study will be analyzed by the GeoEAS software. (Englund and Sparks, 1988). The primary objectives of the geostatistical pilot study will be the development of a semivariogram to describe the spatial variability of PCB concentrations in the Kalamazoo River and to assess the implication of various sampling densities on the reliability of future mapping activities. In addition to PCB concentration data, depth of sediment may also be analyzed by geostatistical techniques. Results of the sediment characteristics and geostatistical pilot studies will be reviewed to determine the best design for a Phase II sediment sampling program to meet the objective of alternative assessment during the RI.

#### 5.4.1.4 Kalamazoo River Exposed Former Impoundment Sediment Investigation

The removal of the Plainwell, Otsego, and Trowbridge dams by MDNR to their sill elevations resulted in significant volumes of historical Kalamazoo River sediment being released or exposed above the current Kalamazoo River water line. Existing information indicates that a portion of these sediments contain PCBs. The areal extent and

general distribution of PCB levels in the exposed sediment deposits cannot be adequately characterized for the purposes of the RI/FS by the existing data alone. Therefore, as directed by MDNR, an investigation will be undertaken to provide an assessment of PCB distribution within these areas. This investigation will include the establishment of six transects within each of the former Plainwell and Otsego Impoundments (Figures 7 and 8), and nine transects within the former Trowbridge Impoundment (Figure 8). The outward lateral extent of the former impoundment transects will be established in the field on the basis of a set of three alternative criteria. The first criterion will be extension of the transect until sediment/soil PCB concentrations are below detection [ $<1$  milligrams per kilogram (mg/kg)] using immunoassay PCB testing procedures. The second criterion will be an extension of the transect until the native soil/gray paper waste interface can be identified. This second criterion will only be used if a correlation between non-detectable PCB concentration and the interface can be established. The third criterion will be extending the transect until a physical barrier to sediment deposition, such as a steep bank, can be identified.

Along each transect at the initially established outer boundary of the estimated extent of exposed sediments containing PCBs, a core sample will be taken to extend through any grey soils and into underlying darker soil. Samples from the 0- to 6-inch interval and each subsequent 1-foot interval to depth of refusal will be screened using the immunoassay field kit with a standard PCB concentration of 1 ppm. If any sample is greater than 1 ppm the boundary will be

extended. If all samples are below 1 ppm the sediment sampling will continue towards the river using the field screening method until samples are greater than 1 ppm. Subsequent samples along each transect will be analyzed using traditional lab techniques (Method 8080).

Along each transect in the former Plainwell and Otsego impoundments, five sample locations will be established. Along each transect in the former Trowbridge Impoundment, eight sample locations will be established. Each sample location will be surveyed to accurately record its location and elevation. Each core sample will extend through any gray soils and into underlying darker soil. If there is evidence of residuals at the bottom of the core, a new deeper core will be taken adjacent to the first. At each of these locations, samples for PCB analysis will be collected from the 0 to 6-inch interval and each subsequent one-foot interval to depth of refusal. The 0 to 6-inch interval for all cores and the deeper intervals for half the cores will be analyzed for TOC content. Every sample will be described using the Unified Soil Classification System and will be photographed. Three sample locations per impoundment will also be selected for a material characterization analysis. At these three locations per impoundment, samples will be collected at 6-inch intervals with analyses being performed for physical characterization including consolidation, particle size, percent moisture, and density.

One sample location per impoundment will be screened for CLP TCL/TAL constituents. Samples will be taken from the 0- to 6-inch and 6- to 18-inch interval and analyzed.

#### 5.4.1.5 Kalamazoo River and Portage Creek Floodplain Soils

The transport of PCBs can result from the erosion, resuspension, and deposition of sediments. The transport mechanism is greatly influenced by flow conditions and location-specific channel geometry. Historical flood events on the Kalamazoo River may have produced conditions conducive to sediment transport and deposition onto the floodplain areas adjacent to the river channel. Of particular interest to the occurrence and distribution of PCBs in floodplain soils are flood events that occurred from the time PCBs probably first appeared in Kalamazoo River sediments (circa mid-1950s) to the present. Floods of over 25-year recurrence intervals occurred in the Kalamazoo basin in 1947, 1948, 1950 and 1985. The 1985 high flow is the only event exceeding the expected 25-year discharge since the introduction of PCBs to the Kalamazoo River. The April 1947 flows were in excess of the estimated 100-year recurrence interval (FEMA, 1981; 1984). More recently, high discharges have occurred in 1975, 1978, 1982, 1984, 1985 (FEMA, 1981; 1984; 1989), and 1989 (USGS, 1990).

Since there appears to be no reliable means to assess the potential of PCBs to have been transported to the floodplain of the Kalamazoo River based on existing information, a phased investigation will be undertaken which will examine flood-prone areas in order to assess the presence of PCBs. As part of this evaluation, available flood information will be characterized and the 100-year floodplain will be defined. Based upon analysis of existing floodplain information, select sampling and analysis will be performed. Floodplain information from FEMA Flood Insurance Studies (FEMA, 1981; 1984; 1989) and

USGS Flood Prone Area Maps (USGS, 1973; 1974; 1976) have already been examined. HEC-2 water surface profile modeling performed for former impoundments by GZA-Donohue (1990) has also been examined. The 100-year floodplain delineation shown in Figures 4 through 9 has been compared to plat maps indicating property ownership for lands adjacent to the Kalamazoo River from Morrow Lake Dam to the Trowbridge Dam and for Portage Creek from Cork Street to the confluence with the Kalamazoo River. To assure complete coverage, the 100-year floodplain for the pre-drawdown period at the former impoundments was also determined.

A total of five transects will be established between the confluence with Portage Creek and the City of Allegan. The transects extending to the approximate limit of the 100-year floodplain are presented in Figures 4, 6, 7, and 8. Land ownership and potential usage were considered in the selection of transects. The initially selected locations include recreational lands owned by various municipalities. The upstream-most transect will be located in Verburg Park, just south of Paterson Street in Kalamazoo (Figure 4). The next transect will be placed south of D Avenue on land owned by Cooper Township (Figure 6). These two transects will extend outward on the west bank due to the fact that the east bank is privately owned. The third transect is similar since only the south side of the Kalamazoo River is publicly owned. This transect will be placed in Brookside Park, Otsego (Figure 7). The fourth transect will be an extension of an impoundment transect located in the former Otsego Dam Impoundment on MDNR-owned land (Figure 8). The final transect will

be located downstream of Trowbridge Dam. The specific location will be defined when land ownership is determined and access is granted.

At each transect, samples will be collected from approximately eight locations within the floodplain characterized by a flood recurrence interval of approximately 100 years. Although the sampling will extend to the 100-year floodplain elevation, samples will be biased to the areas closer to the Kalamazoo River. This is due to the fact that since the presumed introduction of PCBs in the Kalamazoo watershed (i.e., mid-1950s), there has been only one flood (1985) exceeding a 25-year recurrence interval. Each sampling location will be surveyed to accurately record its location and elevation. At each location two samples for PCB analysis will be collected at 6-inch intervals to a depth of 12 inches. TOC content of the 0- to 6-inch interval will also be determined. Samples taken near the boundary of the estimated 100-year floodplain will be screened by immunoassay PCB testing procedures. If the 100-year floodplain boundary sample has detectable PCB ( $>1$  mg/kg), the transect will be extended until the soil PCB concentration is less than detection ( $<1$  mg/kg). If the initial boundary sample is below detection, sampling will proceed along the transect toward the Kalamazoo River. At the two locations nearest the Kalamazoo River along each transect an additional sample 12- to 24-inches deep will be collected and analyzed for PCB concentration. One location will be selected from each of the five floodplain transects for CLP TCL/TAL analyses.

Additional floodplain samples will be obtained in the lower Portage Creek area (Figure 4). Despite the fact that portions of lower

Portage Creek have been channelized for flood control, two areas where flooding is suspected to have occurred have been targeted for further characterization of PCBs.

The first area is a flood-prone area located north of Reed Street. Within this area, a total of five sampling locations will be randomly distributed. The second area is near Upjohn Park located adjacent to Crosstown Parkway on the east bank of Portage Creek. At this location, a Portage Creek transect will be established and a total of five sampling locations will be placed along this transect. The areas sampled will cover the floodplain represented by a flood recurrence interval of approximately 100 years. Sampling will be performed at 6-inch intervals to a total depth of 12 inches below the surface. Each of the surface samples (0- to 6-inches) will be analyzed for PCB and TOC content, while the deeper samples (6- to 12-inches) will be analyzed for PCBs only.

If the results of the first phase of this investigation indicate a significant issue involving floodplain soil contamination along the Kalamazoo River or Portage Creek, then a second phase of investigation would be undertaken. In the second phase, further definition of the nature and extent of floodplain contamination through additional sampling and a more in-depth analysis of flood history will be performed. This will be accomplished by additional floodplain transect sampling and flood event water-surface profile analysis. Should flood analysis be required, the Kalamazoo River cross-section data collected during the sediment probing would be used in the development of a hydrodynamic model.

The preceding discussion of floodplain soil sampling has been limited to those lateral areas adjacent to the Kalamazoo River (and Portage Creek) encompassed by floods of a 100-year recurrence intervals. Other areas which by definition are also in the floodplain are the islands within the channel. Inspection of historical aerial photographs indicate the formation or expansion of many of these islands since the 1950s, with the greatest accumulation of sediments occurring after the drawdown of the former impoundments. Although a final sampling strategy for the characterization of these island deposits has not yet been developed, this Work Plan acknowledges the existence of the areas of accumulated sediments and the need to address them in the subsequent phase of work.

5.4.1.6 Former Impoundment Sediment and Floodplain Soil Sampling for EA

Former impoundment sediment samples and floodplain soil samples will be collected to assess the exposure of terrestrial invertebrates (earthworms) and a terrestrial mammal (deer mouse) to PCBs as part of EA activities developed by MDNR and USEPA. The work plan providing the rationale for EA activities will be prepared by MDNR. The Biota Sampling Plan (Camp Dresser & McKee, 1993) specifies certain areas where soils will be assessed for the presence of PCBs and some of the methods to be used. The methods are further described below.

The Biota Sampling Plan identifies 12 screening areas from which floodplain soil and former impoundment sediment samples will be taken in an initial phase. Based upon the results of PCB analyses, five

subareas will be selected as Terrestrial Biological Sampling Areas (TBSAs) for biota and additional sampling of floodplain soil and former impoundment sediment. The purpose of the initial phase is to identify a limited number of collection areas which represent a wide range of PCB levels in soils. As noted by the sampling plan, other factors will also be considered in selecting the best biota sampling areas for the EA.

The 12 screening areas are:

- Just upstream of Swan Creek confluence with the Kalamazoo River (1 area);
- Upstream of Trowbridge Dam (4 areas);
- Upstream of Otsego Dam (3 areas);
- Upstream and downstream of Plainwell Dam (3 areas); and
- Kalamazoo River near Fort Custer State Recreation Area (1 area).

These are identified on maps in the Biota Sampling Plan and are presented in this Work Plan on Figures 7, 8, 11, and 21. The screening areas identified by MDNR are approximately 1,500 feet by 500 feet in size.

The approach to the initial phase of sampling is based upon the geographic scale of the second phase activities and the need to characterize average exposure levels of PCBs. In the second phase, mice will be collected from a grid within a TBSA of approximately 200 feet by 250 feet. Soil sampling procedures are described by the Biota Sampling Plan (Camp Dresser & McKee, 1993).

**5.4.1.7 Floodplain Soils Sampling Downstream of Lake Allegan**

The floodplain of the Kalamazoo River downstream of Lake Allegan Dam comprise numerous wetland areas. Directly downstream of the Lake Allegan Dam is the Allegan State Game Area containing three wetlands, Koopman Marsh, Swan Creek Marsh, and Ottawa Marsh (Figures 11 and 12). Although some of the wetlands contain open water, most areas within these wetlands are seasonally flooded.

The wetlands may be depositional areas during periods of high flow. To assess extent of PCBs, if any, deposition and bioavailability within the wetlands directly downstream of Lake Allegan, floodplain soil samples will be collected along three transects located in the Koopman Marsh/Swan Creek Marsh area. Along each transect, five core samples will be collected at approximately 100-foot intervals. The upper six inches of each core will be analyzed for PCBs and TOC. The 6- to 12-inch interval and 12- to 24-inch interval will be analyzed for PCBs only.

As required by MDNR, to assess whether the Ottawa and Pottowatamie marshes are acting as sinks for chemicals, three cores will be collected from each of these areas. The approximate locations of cores OM-1, OM-2, OM-3, are shown on Figures 11 and 12. The approximate locations of cores PM-1, PM-2, and PM-3 are shown on Figure 13. These locations however, may be adjusted in the field to assure sampling of depositional environments and to allow access. The 0- to 2- inch, 2- to 6-inch, 6- to 12-inch, 12- to 24-inch, and 24- to 36-inch intervals will be analyzed for PCBs. For one of the three

cores the 2- to 6-inch interval will be analyzed for CLP TCL/TAL constituents.

#### 5.4.1.8 Geochronological Dating of Sediment and PCB Deposition

To provide information on the approximate rates of historic sediment deposition and the transport history of PCBs, cores from the Allegan City Impoundment and cores from Kalamazoo Lake will be analyzed for the radioactive isotope cesium-137 (Cs-137). Cs-137 is a radionuclide distributed globally in the atmosphere as a product from nuclear weapons tests, whose concentration in fallout peaked in the 1959-1963 period. In sediment its peak concentration may be used to mark the approximate depth of sediments deposited between 1960 to 1963.

The work will be performed in two phases. In the initial phase two cores will be collected from different locations in each impoundment. Cores will be sectioned at 1-foot intervals and analyzed for Cs-137. This resulting coarse Cs-137 profile will be used to set the core sectioning interval to be applied to two additional cores to be collected from each of these impoundments.

During the second phase of sampling for geochronological dating, each core will be segmented into relatively thin sections for analysis of Cs-137 and PCBs. The sections thickness will be selected to represent approximately three years of deposition. The upper section(s) of each core will also be analyzed for the presence of beryllium-7 (Be-7) to assure the surface layer of the sediment has been retrieved during the coring. If the cores yield an interpretable

Cs-137 profile, a PCB deposition chronology will be developed to estimate historic and recent trends in PCB transport.

5.4.1.9 Source Investigation - Sediment Sampling

To satisfy the RI goal of identifying sources of PCBs to the NPL Site, preliminary research has been conducted regarding industries or facilities which are located in the Kalamazoo River watershed, and may have discharged, purchased, or used PCBs during their operation. These industries may have also discharged other potential constituents of interest. The proposed sampling and data analysis for source identification is designed to assist in the spatial discrimination of the influence of historical contributions of PCBs and other constituents of interest from various sources.

Sixteen locations have been identified in the Kalamazoo River between the Morrow Lake and Lake Allegan for sampling to assess the potential influx of other sources of regulated constituents. Targeted areas for sediment sampling include the immediate locations of discharges or the first downstream area on the same side of the river which, based upon physical features and the results of the sediment characterization, would seem to favor the accumulation of fine-grained sediments. Due to the hydrophobic nature of PCBs, these fine-grained sediments are expected to retain a record of PCB discharge which may only be intermittently evident in effluents or unavailable for discontinued dischargers.

Blasland & Bouck has analyzed fish tissue chromatograms obtained from the Michigan Department of Public Health (MDPH) to ascertain a preliminary understanding of the nature of PCB exposure

to fish. The chromatograms clearly show differences in PCB composition in various stretches along Kalamazoo River and Portage Creek. This suggests additional discharges of PCBs to the Kalamazoo River not previously identified.

Two sediment cores will be obtained in each of the targeted sampling locations. The top six inches of sediment from each core will be analyzed for PCBs and TOC content. Below the 0- to 6-inch interval, the sediment core will be sectioned into samples representing a 6-inch to 1-foot increment and subsequent 1-foot increments thereafter to the total depth of sediment (refusal) or a specified target depth is achieved. This target depth will be determined on a location by location basis, depending on existing sediment PCB concentration data. Core samples will not be obtained in areas of coarse-grained materials. Surface grab sediment sampling techniques will be used if no core can be retrieved. Each increment sample to the target depth will be analyzed for PCBs. The locations and sampling strategy of these samples are listed in Table 5-1. Additional locations may be added if additional potential sources of PCBs or other constituents of interest are identified.

The proposed analytical methods for PCB analysis involve high-resolution gas chromatography (PCB Aroclor method) and are designed to allow further discrimination of the influence of individual contributors through analysis of compositional differences in PCB mixtures. In addition to PCBs, samples will be analyzed for TOC to permit normalization of PCB concentrations to differences in sediment organic

content. Field procedures are contained in the FSP and QAPP, and the PCB analytical method is contained in the QAPP.

#### 5.4.2 Mill Investigations

The focus of the mill investigations is to assess whether any of the existing or former paper mill properties may be a source of PCBs to the Kalamazoo River or Portage Creek. Due to the high detection limit for PCBs in water samples relative to the levels considered significant by MDNR, the sampling activities will focus on mill residuals and solid residue which may come into contact with surface runoff, as well as any other waters discharged to the Kalamazoo River and Portage Creek, other than effluent from permitted wastewater discharges. Aspects of mill operations which are covered by other regulatory programs such as wastewater treatment and discharge will not be included in the RI activities.

The mill investigations will be conducted in a phased approach (Bradford, 1991b; Cornelius 1992a, 1992b). The initial field sampling activities will include sample analysis for PCBs, with selected samples analyzed for PCDDs and PCDFs as directed by MDNR. Based upon the results, additional sampling may be necessary. PCBs are being analyzed due to the presence of these constituents in the Kalamazoo River and Portage Creek. According to MDNR, PCDDs and PCDFs have been included due to their presence in the Willow Boulevard/A-Site OU.

##### 5.4.2.1 Georgia-Pacific Corporation Kalamazoo Mill

The objectives of the investigation will be to:

- assess the potential contribution of PCBs, PCDDs, or PCDFs to the Kalamazoo River from stormwater runoff at the mill.

- assess the presence and distribution of PCBs in the former lagoons; and
- determine whether PCBs are present in the mill's former wastewater treatment system clarifier.

At the Georgia-Pacific Corporation Kalamazoo Mill, process wastewater is sent to the Kalamazoo Water Reclamation Plant, where the influent, effluent, and sludge are monitored for PCBs on a quarterly basis.

Should the initial investigation results indicate the need for further characterization, a second phase of RI activities will be undertaken.

An assessment of the mill's stormwater conveyance will be conducted to locate a representative sediment collection point along the path of stormwater flow. The solids will be sampled at this location and analyzed for PCBs, PCDDs, and PCDFs. This sample will be designated as GPD-1. The location of this sample will be submitted to the MDNR for their concurrence prior to sample collection. The significance of the results of the initial phase of stormwater solids sampling will be assessed and the assessment will be subject to MDNR's concurrence. Concentrations of PCBs, PCDDs, or PCDFs (if any); the potential for off-site migration; and the magnitude of potential loading would be among the factors considered in the assessment.

A sample of solids will be collected from the former primary clarifier and analyzed for PCBs. This sample will be designated as GPC-1.

The locations of the former lagoons at the Georgia-Pacific Corporation Kalamazoo Mill are shown on Figure 14. These lagoons will be investigated to characterize the nature and extent of the residuals. A total of seven soil borings, to be designated GPL-1 through GPL-7, will be drilled to characterize the former lagoons. These borings will be continuously sampled with a hand auger or 2-foot split barrel (split-spoon) sampler for visual classification. If the split-spoon method is not sufficient then a thin-walled piston sampler or coring device will be used. These field methods and all other field methods to be used during this investigation are more thoroughly discussed in the FSP. Selected samples will be homogenized and analyzed for PCBs as described below.

Three borings (GPL-1 through GPL-3) will be drilled in the three former lagoons to the northwest of the mills. Given the location near the Kalamazoo River and the local relief, the lagoons appear to have been shallow and have not been filled-in. Small piles of residuals located at the western ends of the lagoons suggest the lagoons had been excavated. Consequently, if residuals are present, the layer is expected to be thin (<5 feet). As noted previously, these lagoons had received process waste from the former Mill 2 which was not a deinking mill.

Prior to the drilling of borings in the three former lagoons to the northwest of the mills, a preliminary field determination of the horizontal extent of residuals inside and outside of the lagoons will be conducted. The field determination will consist of turning over the top one foot of soil with a hand shovel at a number of locations to

identify the underlying material as either native soil or residuals. The residuals are distinguishable from native soil or sediment by their characteristic grayish-white, clay-like appearance.

Borings GPL-1, GPL-2 and GPL-3 will be advanced to a depth of 2.5 feet below the base of the residuals. Borings GPL-1 and GPL-3 will be advanced through the edge of the residuals piles. The borings will be visually inspected to assess the presence and vertical extent of paper-making residuals. At each boring one surface sample from 0 to 6 inches below the surface will be homogenized and analyzed for PCBs. A soil sample collected from 0.5 to 2.5 feet below the base of the residuals from each of borings GPL-1, GPL-2 and GPL-3 will be homogenized and analyzed for PCBs. If an identifiable interface is observed between the base of the residuals and native soil, the native soil sample interval may be modified to allow collection of a representative sample of the native soil below the interface. The specific location will be identified in the field. Samples in this phase will be allocated based upon the reconnaissance observations of the extent of the residuals around the lagoons including the former drainageway from the lagoons to the Kalamazoo River.

Borings GPL-4 and GPL-5 will be installed in the two former lagoons located near the primary clarifier (Figure 14). These borings will be advanced to a depth of 2.5 feet below the base of the residuals. If an identifiable interface is observed between the base of the residuals and native soil, the native soil sample interval may be modified to allow collection of a representative sample of the native soil below the interface. The specific location will be identified in the

field. At each boring, one surface sample from 0 to 6 inches will be analyzed for PCBs. If residuals are not contained in the 0 to 6 inch sample, then an underlying sample of residuals, if present, will be collected for PCB analysis. A sample from 0.5 to 2.5 feet below the base of the residuals, if present, would be homogenized and analyzed for PCBs. One reconnaissance boring (GPL-6 and GPL-7) will also be installed in each of the lagoons to assess the presence and vertical extent of residuals (if present). These borings will also be advanced to a depth 2.5 feet below the base of the residuals. If an identifiable interface is observed between the base of the residuals and native soil, the native soil sample interval may be modified to allow collection of a representative sample of the native soil below the interface. The specific location will be identified in the field. No chemical analysis will be performed on borings GPL-6 and GPL-7.

The sampling activities at Georgia-Pacific Corporation Kalamazoo Mill property are summarized in Table 5-2. Abandonment procedures for all borings are described in the FSP.

The existing regulatory compliance programs in place at the Georgia-Pacific Corporation Kalamazoo Mill monitor the presence of PCBs in wastewater effluent and sludge (including process water from the deinking facilities at Mills 1 and 3) through on-going quarterly sampling at the Kalamazoo Water Reclamation Plant. Although plant cooling water is non-contact, the flowpaths for cooling water, as well as wastewater previously discharged to the abandoned primary clarifier will be verified.

#### 5.4.2.2 Simpson Plainwell Paper Mill Property

The initial assessment of the Simpson Plainwell Paper Company Mill property will focus on the evaluation of whether PCBs are present at the closed mill lagoons, the presence of PCBs in the mill's former wastewater treatment system, and whether stormwater conveyances contribute PCBs, PCDDs, or PCDFs to the Kalamazoo River. The sampling activities at Simpson Plainwell Paper Company Mill are summarized in Table 5-3. Should the initial investigation results indicate the need for further characterization, a second phase of RI activities will be undertaken.

A mill property drainage analysis will be performed to determine the overall stormwater catchment area and to locate a representative stormwater sediment collection point. The exact location of the sample will be submitted to the MDNR for their concurrence once the drainage analysis is complete. A solids sample will be collected and identified as SPD-1. The solids will be analyzed for PCBs, PCDDs, and PCDFs. The significance of the results of the initial phase of stormwater solids sampling will be assessed and the assessment will be subject to MDNR's concurrence. Concentrations of PCBs, PCDDs, or PCDFs (if any); the potential for off-site migration; and the magnitude of potential loading would be among the factors considered in the assessment.

A solids sample (0 to 6 inches) will be collected from the area of the former primary clarifier. A solids will be collected from the open drain which previously conveyed deink plant wastewater. These samples will be designated SPC-1 and SPC-2, respectively (Figure 15).

and will be analyzed for PCBs. One solids sample will be collected from the former secondary clarifier (SPC-3) and analyzed for PCBs.

The locations of the former lagoons at the Simpson Plainwell Paper Company Mill are shown on Figure 15. These lagoons will be investigated to characterize the residuals which may be present at these locations. A review of aerial photographs indicates that the former lagoon boundaries appear to be distinct. For this reason, the borings to be drilled as part of the mill property investigation are focused within the lagoons.

A total of 13 soil borings, designated SPL-1 through SPL-13, will be installed to characterize the lagoons. These borings will be continuously sampled with a 2-foot split-barrel (split-spoon) sampler for visual classification and for standard penetration resistance testing. If a split-spoon method is not sufficient, then a thin-walled piston sampler or a coring device will be used. The field methods to be employed during this investigation are detailed in the FSP. Analytical methods are detailed in the QAPP.

Borings SPL-1 through SPL-4 and SPL-6 through SPL-13 will be installed in the row of 13 former lagoons shown in Figure 15. Boring SPL-5 will be installed in former lagoon K. The borings will be advanced to a depth 2.5 feet below the base of the residuals or fill material. If an identifiable interface is observed between the base of the residuals and native soil, the native soil sample interval may be modified to allow collection of a representative sample of the native soil below the interface. The specific location will be identified in the field. Visual classification of the soil encountered at each boring will

be made to verify the vertical extent of the residuals or lagoons. Boring SPL-1 through SPL-5 will be analyzed for PCBs if residuals are encountered. If residuals are not encountered, then borings within the set SPL-7 through SPL-13 will be substituted for PCB analysis. From each of the five selected borings, one surface sample from 0 to 6 inches will be homogenized and analyzed for PCBs. A sample of any underlying residuals will be collected for every 10 feet of residuals. Residuals, if present, are expected to be in a thin layer (< 5 feet); consequently, one sample is expected when residuals are encountered. From each of the borings containing residuals, a sample from 0.5 to 2.5 feet below the base of the residuals will also be homogenized and analyzed for PCBs.

Boring SPL-6 will be installed in the area of the former aeration basin. This boring will be advanced to a depth of 2.5 feet below the base of the former basin sediment. If an identifiable interface is observed between the base of the residuals and native soil, the native soil sample interval may be modified to allow collection of a representative sample of the native soil below the interface. The specific location will be identified in the field. A sample of the solids, if present, the surficial 0 to 6 inches, if sediment is not present, will be analyzed for PCBs. A sample from 0.5 to 2.5 feet below the base of the solids/fill will be homogenized and analyzed for PCBs. In addition to the proposed soil boring program to characterize any residuals remaining in the former lagoons, residuals, if discovered during mill construction activities during the course of the RI, would be characterized as part of this investigation.

#### 5.4.2.3 Portage Paper Mill Property

Sampling at the Portage Paper Company Mill (formerly the Allied Paper, Inc. Bryant Mills B, C, D, and E and also known as Performance Paper Mill) will be conducted to assess the potential for PCB, PCDD, and PCDF transport to Portage Creek via stormwater runoff and to determine whether residuals that collect within wastewater and process water conveyances could be a source of PCBs to Portage Creek. The mill investigation will focus on sampling solids from stormwater and wastewater drainage that have collected at a common point.

The specific objectives of this investigation will, therefore, be to:

- Assess whether a large stormwater catchment area at the mill is a potential source of PCBs, PCDDs, and PCDFs to Portage Creek;
- Assess whether the former pipe from Mill A (reputed to still exist) to Portage Creek is a current source of PCBs to the Portage Creek; and
- Determine if PCBs exist in the mill's wastewater conveyance system (i.e., pump station, Grey Tank, and Bryant Clarifier).

The drainage system at the Portage Paper Company Mill includes the paved area and building drainage systems. The paved area drainage system consists of drains in the mill parking lots. Paved areas appear to be the main contributors to stormwater runoff into Portage Creek east of Mill C (Figure 16).

The building drainage system collects and conveys process wastewater and stormwater runoff from the flat-roofed buildings. The

water, collected by the building area drainage system in the sump of a pump station, is pumped to the Grey Tank which serves as a collection point for all building drains at the mill. The water from the Grey Tank is then pumped to the Bryant Clarifier which allows solids to settle before being discharged to the city sanitary sewer system or returned to the Mill as process water. Portage Paper Company has applied for a permit to discharge the clarified effluent from the Bryant Clarifier to Portage Creek.

The flow collected by the building drainage system is primarily rainfall collected by the roof drains.

To assess the stormwater runoff as a potential source, the solids at the outfall east of Mill C will be sampled. The sample (PPC-1) will be analyzed for PCBs, PCDDs, and PCDFs. The location of the sample will be determined during site reconnaissance. The significance of the results of the initial phase of stormwater solids sampling will be assessed and the assessment will be subject to MDNR's concurrence. Concentrations of PCBs, PCDDs, or PCDFs (if any); the potential for off-site migration; and the magnitude of potential loading would be among the factors considered in the assessment.

If the pipe from former Mill A can be located, the solids from within the pipe will be analyzed for PCBs. This sample will be designated as PPC-2.

To determine whether the mill wastewater conveyance system is a source of PCBs to the Kalamazoo River, the solids from the pump station south of Mill D (PPC-3) will be collected and analyzed for PCBs. The exact location of this sample will be determined during

field reconnaissance. The solids from the building area drainage system will be collected from the sump of the pump station and the Grey Tank, and analyzed for PCBs. These samples will be designated PPC-4 and PPC-5, respectively. The solids from the Bryant Clarifier will also be sampled (PPC-6) and analyzed for PCBs. The sampling activities at Portage Paper Company Mill are summarized in Table 5-4.

#### 5.4.2.4 Former King Mill Property

RI activities at the former King Mill will be conducted to accomplish the following:

- Evaluate the potential for stormwater runoff contribution of PCBs to storm sewers;
- Assess whether the 48-inch pipe, which apparently discharged mill wastewater to the Kalamazoo River, is a potential source of PCBs to the Kalamazoo River;
- Assess the presence of PCB-containing residuals within the former lagoons; and
- Determine if PCBs are present in the soil in the areas of the former clarifiers.

The sampling and field activities at the former King Mill are summarized in Table 5-5. To assess the potential for surface runoff contribution of PCBs, PCDDs, and PCDFs to storm sewers, a site drainage analysis will be conducted. This drainage analysis will be performed to determine the overall stormwater catchment area and to locate a representative collection point. The solids at this point will be sampled and analyzed for PCBs, PCDDs, and PCDFs, as required by MDNR. The location of the sample will be determined once the

drainage analysis is complete. This sampling location, designated KMD-1, will be submitted to the MDNR for approval prior to sampling. The significance of the results of the initial phase of stormwater solids sampling will be assessed and the assessment will be subject to MDNR's concurrence. Concentrations of PCBs, PCDDs, or PCDFs (if any); the potential for off-site migration; and the magnitude of potential loading would be among the factors considered in the assessment.

An assessment of the 48-inch diameter pipe as a potential current source of PCBs to the Kalamazoo River will be conducted. Available historic information regarding the pipe, which apparently conveyed mill wastewater to the Kalamazoo River, will be developed to determine the existence of tributary pipes. The existing pipe will also be observed to determine whether it discharges during storm events. A sample of solids will be collected from the effluent end of the pipe and analyzed for PCBs. This sample will be designated KMS-1.

The locations of the former lagoons, as shown on Figure 17 will be investigated to characterize the horizontal and vertical extent and the nature of the residuals placed or dewatered at these locations. The areas where the former clarifiers stood will also be assessed.

A total of eight soil borings (KM-1 through KM-8) will be installed to evaluate the former lagoons and former clarifiers. These borings will be continuously sampled with a 2-foot split-barrel (split-spoon) sampler for visual classification. If a split-spoon method is not sufficient then a thin-walled piston sampler or a coring device will be used. The field methods and all other field methods used during this

investigation (i.e., homogenization of samples, drilling techniques) are detailed in the FSP and the QAPP. Selected samples will be homogenized and analyzed for PCBs, as described below.

Borings KM-1 and KM-2 will be installed at the locations of the former clarifiers as shown on Figure 17. These borings will be advanced to a depth of four feet. Two 2-foot split-spoon samples will be collected at each of these borings. If a split-spoon method is not sufficient, then a thin-walled piston sampler or a coring device will be used. The top 6-inch increment of the surface sample (0- to 6- inch) and the second 2-foot sample (2-foot to 4-foot) will be homogenized and analyzed for PCBs.

Three borings (KM-3 through KM-5) will be installed in the former north-south, elongated lagoon. The borings will be preceded by a field reconnaissance of the area to determine the horizontal extent of residuals in the lagoon and to assess the presence of paper residuals outside the lagoon boundaries. The reconnaissance will consist of turning over one foot of soil with a hand shovel and identifying the underlying material as native soil or residuals. Preliminary reconnaissance indicates that the residuals at former King Mill are confined to the former lagoon. Borings KM-3 through KM-5 will be advanced to a depth of 2.5 feet below the base of the residuals. Borings KM-3 and KM-5 will be used only for the determination of the vertical extent of paper residuals within the lagoon and no chemical analysis will be conducted on the soil samples collected at these borings. At boring KM-4, a surface sample from 0 to 6 inches will be analyzed for PCBs. A separate sample of the residuals, if present in

a distinct layer, will be collected and analyzed for PCBs. A soil sample, collected from 0.5 to 2.5 feet below the base of the residuals, will be homogenized and analyzed for PCBs from each of these borings. If an identifiable interface is observed between the base of the residuals and native soil, the native soil sample interval may be modified to allow collection of a representative sample of the native soil below the interface. The specific location will be identified in the field.

Three borings (KM-6 through KM-8) will be installed in the former northeast lagoon. Preliminary reconnaissance has yet to confirm the precise location of this lagoon which had been located to the northeast of the elongated lagoon. Additional reconnaissance will be conducted with a hand shovel to assess the presence and horizontal extent of residuals in the area of this former lagoon prior to installing borings. Borings KM-6 through KM-8 will be installed within the boundaries of this former lagoon, when the boundaries are defined by reconnaissance. These borings will be advanced to a depth of 2.5 feet below the base of the residuals. If an identifiable interface is observed between the base of the residuals and native soil, the native soil sample interval may be modified to allow collection of a representative sample of the native soil below the interface. The specific location will be identified in the field. Borings KM-6 and KM-8 will be used only for the determination of the vertical extent of paper-making residuals within the lagoon and no chemical analysis will be conducted on the soil samples collected at these borings. At boring

KM-7, samples for PCBs will be collected using the approach described above for boring KM-4.

Samples in this phase will be allocated based upon the reconnaissance observations of the extent of the residuals around the lagoons.

#### 5.4.2.5 Former Monarch Mill Property

Two borings (MM-1 and MM-2) will be installed along the northern side of the property (just south of Cork Street) at locations down-gradient of the mill where the mill race had discharged to Portage Creek (Figure 18). The locations apparently were covered with fill during dismantling of the mill in 1980.

A sample will be collected with a 2-foot split-spoon sampler at the depth of each boring where previous mill race sediments are encountered. If a split-spoon method is not sufficient then a thin-walled piston sampler or a coring device will be used. If no sediments are encountered by a depth of 15 feet or if auger refusal is encountered, no samples will be collected. Retained sediment samples will be analyzed for PCBs. The sampling and field activities are summarized in Table 5-6. The Monarch Clarifier is being sampled as part of the RI at the Allied Paper, Inc. OU.

#### 5.4.2.6 King Street Storm Sewer

The area of the King Street storm sewer (Figure 19) to be investigated is proximal to the storm sewer's outfall located between the northwest section of the King Highway Landfill OU and Riverview Park (Figure 4), and includes the floodplain soils adjacent to the inlet

of the Kalamazoo River which receives the discharge from the storm sewer.

Two separate outfalls have evidently discharged to the area: a 10-foot by 5-foot concrete box culvert with brick headwall and a 48-inch concrete circular culvert. Two abandoned manholes are located to the east of the 48-inch culvert. The larger of the outfalls which is located to the east of the smaller outfall, appears to be the actual King Street storm sewer outfall. The smaller outfall appears to have been the wastewater outfall from the former King Mill. The land and outfall structures are apparently owned by the city of Kalamazoo. This area is located within a deciduous forested area.

Some of the sediment in the inlet, as well as the soil adjacent to the inlet, have the grey-like appearance and clayey consistency of paper residuals. Previous investigation of the area included the collection of 14 soil samples along the eastern side of the drainage feature through which the King Street storm sewer discharges to the Kalamazoo River. The previous samples from 0 to 3.5 feet have detected PCBs in the floodplain soils near the storm sewer in concentrations ranging from non-detectable to 99 mg/kg. Further information can be found in the DCS Report

A total of eleven borings will be installed, as shown in Figure 19. Eight of the borings (KSHB-1 through KSHB-4 and KSHB-8 through KSHB-11) will be drilled along the western side of the drainage feature where no previous samples have been collected. These borings will be advanced to a depth of three feet or to the water table, whichever is less. Two samples from each of the borings KSHB-1 through KSHB-

4 will be collected and analyzed for PCBs. The first sample will be obtained from the 0 to 6-inch interval below the surface, and the second sample will be collected from the 0- to 6-inch interval below the bottom of the paper-making residual layers. If no evidence of paper-making residuals are found, then the sample will be collected from 1.5 to 2.5 feet below the surface or the one-foot interval above the water table, as conditions warrant. Borings KSHB-8 through KSHB-11 will be collected to determine the extent of paper-making residuals on the western side. These borings will be visually inspected, but no chemical analysis will be performed on samples from borings KSHB-8 through KSHB-11.

Boring KSHB-5 will be drilled to assess the potential contribution from the 48-inch circular culvert. Borings KSHB-6 and KSHB-7 will be drilled in the area on the eastern side inlet where previous samples were collected. The data from these two borings will be compared to the previously collected data to assess if any changes have occurred since the 1989 sampling activities. Each of the borings will be advanced to a depth of three feet or to the water table, whichever is less. Two samples from each boring will be analyzed for PCBs. The first sample will be collected from 0 to 6 inches below the surface and the second sample will be collected from 1.5 to 2.5 feet below the surface, or from 2 feet to the top of the water table, as conditions warrant. Each sample will be collected and handled as described in the FSP. (Blasland & Bouck, 1993d). The deeper sample from KSHB-5 will also be analyzed for the CLP TCL/TAL constituents.

Sampling activities at King Street storm sewer are summarized in Table 5-7.

#### 5.4.3 Surface Water PCB Transport Investigation

As documented in the DCS Report, a large amount of surface water analytical data exists for portions of the NPL Site. However, the existing information may not represent current conditions and appears to be inadequate for the characterization of the mechanisms of PCB transport within the Kalamazoo River.

Sample collection frequency for suspended sediment and PCB analyses will be based upon the general sampling requirements for estimating annual material transport in event-response rivers. Event-response rivers exhibit a positive relationship between material concentrations and river flow, with much of the annual material transport occurring during relatively few periods of high flow (Yaksich and Verhoff, 1983). The Kalamazoo River is expected to be an event-response river with regard to the transport of sediment and PCBs based on the hydrology of the River and fine-grained sediment availability.

A review of material-transport calculation methods and analysis of sampling requirements for estimating sediment-sorbed material transport in event-response rivers concluded that there is no definitive method of determining the number of requisite samples for a certain confidence level in an annual estimate (Yaksich and Verhoff, 1983). However, sampling efforts can be directed toward various flow conditions to assure proper sampling coverage (i.e., minimum estimation error for total sampling effort). When the adequate number of PCB observations over a wide range of river discharge are available, the sampling effort can be allocated in proportion

to the product of the standard deviation of instantaneous PCB transport (i.e., flow x concentration) for a particular flow interval and the proportion of time spent in that interval. Typically, the standard deviations of transport for high flow intervals are typically very large. Based upon experiences in sample effort allocation of this type for other rivers (Bodo and Unny, 1983; Dolan et al., 1981; Verhoff et al., 1980; Yaksich and Verhoff, 1983), most of the sampling effort will be directed toward the representation of two to three major runoff events per year at a given location, with substantially less effort directed during baseflow or low-flow conditions.

In addition to estimating the annual transport at various locations, the water monitoring program will also characterize the ambient water column during summer months. Ambient PCB concentrations during summer are expected to reflect, and possibly influence, exposure to organisms when feeding and other transfer processes are generally at their annual peak. The sampling plan for the surface water investigation is summarized in Table 5-8.

The event-based surface water samples will be collected at:

- Michigan Avenue on Portage Creek in Kalamazoo (Figure 4);
- River Street in Comstock and Michigan Avenue in Kalamazoo, both upstream of the confluence (Figure 4);
- Farmer Street, downstream of the Otsego City Dam (Figure 7);
- Highway M-118 which is downstream of the Allegan City Dam (Figure 9); and
- Highway 89 downstream of Lake Allegan (Figure 11).

Approximately eight samples will be collected during each of the three runoff events at each location (with the exception of the location of Lake Allegan). Approximately four samples would be collected for analysis during the period of rising stage (i.e., increase in water levels subsequent to major storm events). As a practical matter, however, this sampling will possibly involve the collection of more than four samples during the period of rising stage for certain events. The selection of samples for analysis will be conducted after the peak discharge characteristics have been evaluated. At the Highway 89 location, two samples will be collected during each of three runoff events. The sampling intensity during runoff events is less than that at other sampling locations due to the expected dampening affect of Lake Allegan on streamflow, sediment transport and variability of water quality.

Surface water samples will also be collected at Cork Street and Alcott Street on Portage Creek as part of the RI for the Allied Paper, Inc. OU.

Depth-integrated samples will be collected following the procedures outlined in the FSP. Surface water samples will be analyzed for total PCBs and total suspended solids (TSS). Field measurements for surface water samples will include temperature, pH, dissolved oxygen, conductivity, and turbidity. One event sample from each water sampling location will be analyzed for CLP TCL/TAL constituents.

The baseflow surface water sampling locations include the event-based locations previously described and an additional sampling location at D Avenue in Cooper Township. Six to eight surface water samples will be collected from these seven locations during the summer. Sampling would begin on a bi-weekly basis in mid-June, pending Work Plan approval, and

continue on that basis until mid-September. A round of late-autumn and late-winter water samples will also be collected.

A round of surface water samples will be collected from Michigan Avenue on Portage Creek and at River Street, Michigan Avenue, D Avenue, the Otsego City Dam, and Highway M-118 and Highway 89 on the Kalamazoo River during summer low-flow conditions and analyzed for the CLP TCL/TAL constituents described in Table 4-1. These results will be compared to those obtained from the event-based sampling activities.

Approximately 32 samples would be collected during this investigation from most of the locations. Approximately 24 samples per location will be collected during high-flow events. In addition, the baseflow water column sampling should produce eight to ten samples during periods of less than 1,000 cfs. It is expected that the early response to events which do not ultimately produce high flow will provide several additional samples for the less-than-1,000-cfs interval.

There are two USGS stage gauges on the Kalamazoo River at Comstock and Fennville; two active gauges on Portage Creek; two active gauges on West Fork Portage Creek upstream of Monarch Mill Pond; and one inactive gauge at Reed Street on Portage Creek below the former Bryant Mill Pond (USGS, 1990). Information from these gauges will be used to evaluate the sediment and PCB concentration data collected and in calculating transport rates. The Comstock gauge is a Telemark gauge providing real-time stage data via telephone. Real-time data from this gauge will be used to make decisions regarding event sampling. The Comstock gauge and precipitation conditions in Kalamazoo will also be monitored. The USGS stage-discharge relationship for the Comstock gauge

will be used to calculate the daily flow rates. A high-flow event will be considered to begin when the flows exceed 1,000 cfs at the Comstock gauge for two consecutive days and the precipitation data indicate continuing increases. The sampling crew will be mobilized within 24 hours of confirming high flow conditions. One surface water sample will be collected from each station each day. Sampling will continue daily unless the daily decrease in flow is less than 100 cfs, in which case the sampling frequency would be reduced to every other day or twice weekly. A total of six to eight samples will be analyzed for each location for each event distributed over the range of flow conditions.

In addition to the USGS gauge information, direct in-stream flow measurements will be made during each sampling event at two locations on the Kalamazoo River and one location on Portage Creek. The locations for direct in-stream measurement may be rotated each sampling period with reference elevations (such as "taping-down" from a fixed reference mark on a bridge) taken at every location. This would allow for the development of preliminary river stage discharge relationship for currently ungauged locations. The flows will be measured using an electromagnetic velocity meter. The direct measurements will provide instantaneous flow measurements for the different reaches.

#### 5.4.3.1 Data Requirements for PCB Fate and Transport Modeling

MDNR has directed the KRSG to ensure that the data collected as part of the RI be sufficient to operate USEPA surface water quality and bioaccumulation models being contemplated by MDNR. A summary of these models, data requirements, and how the RI will meet the data requirements of the models is contained in Appendix B.

#### **5.4.4 Aquatic Biota Investigation**

The monitoring of PCB concentrations in aquatic biota will generate data of sufficient quality to: 1) support a baseline EA; 2) evaluate the status of fish consumption advisories; and 3) characterize temporal trends and spatial gradients in PCB bioavailability. Each of these objectives requires a statistically valid characterization of PCB concentrations in resident fish.

The Biota Sampling Plan (Camp Dresser & McKee, 1993) is part of the EA prepared by MDNR's consultant. Blasland & Bouck will conduct the field sampling activities in the Biota Sampling Plan except where noted in that Plan.

Aquatic species selected for collection and PCB analyses are as follows:

- Snapping turtle;
- Rough fish (carp);
- Forage fish ; and
- Game fish.

The Biota Sampling Plan also includes the collection of terrestrial invertebrates and mammals to support the ecological assessment portion of the EA.

#### **5.4.5 Wetlands Assessment**

Wetlands will be identified using methods outlined in the Corps of Engineers Wetlands Delineation Manual (Environmental Laboratory, 1987). Relevant available state and federal information files, maps, and aerial photographs will be reviewed to locate potential wetland areas. Wetland characterization will rely on these information sources to ascertain the

presence of: 1) hydrophytic vegetation; 2) hydric soils; and 3) wetland hydrologic features.

The sequence for defining wetlands is as follows:

- Review USGS topographic maps for the NPL Site area to identify possible wetland areas and surface water bodies;
- Review National Wetland Inventory (NWI) Maps, state, and/or local wetland maps, and any pertinent MDNR information files;
- Review available United State Department of Agriculture (USDA) Soil Conservation Service Soil Survey maps of the area for the presence of hydric soil units;
- Review aerial photos of the area for signs of wetlands (i.e., standing water areas, hydric vegetation);
- If signs of wetlands are observed in aerial photos, review available site-specific data regarding soils, vegetation, and hydrology; and
- Conduct field verification of desktop-derived conclusion (on-site review).

The presence of endangered, threatened, and rare species at the Site will be investigated as part of the Wetlands Assessment. Information has been requested from MDNR's Natural History Heritage Program regarding species' habitat. If this information indicates that an endangered, threatened, or rare species may be present, a ground truth investigation will be performed.

#### 5.4.6 Water Well Inventory

This task will also include the identification of existing residential, municipal, and industrial water supply wells located within one-quarter mile

of Portage Creek and Kalamazoo River. If no wells are identified within one-quarter mile of the study area, the radius will be increased to one-half mile. Appropriate municipal, county, and state records for the period September 1968 to September 1990 have been consulted as the basis for private well identification. More recent records will also be reviewed, as available. The information, including well logs for wells that are identified, will be summarized and the well locations will be depicted on a map. There are no plans to sample private and municipal wells. This work task has already been initiated and is almost complete.

#### 5.4.7 Site Mapping

Site maps illustrating relevant water features, wetlands, floodplains, and areas of ecological importance will be prepared throughout the RI/FS. The maps will be of a sufficient detail and accuracy to locate and report the existing and future work at the Site. The base maps will be stored in a digital format to facilitate the changing of display scales and the addition of new information. Some of these maps have already been prepared and are contained in the RI/FS Work Plan. A current topographic map with 5-foot contours exists for the site.

#### 5.4.8 Technical Memoranda

Nine technical memoranda will be submitted to MDNR to report the following:

- Mill property investigation stormwater drainage analyses and proposed solids sampling location.;
- Water-well inventory;
- Results of the first-phase of soil sampling to characterize candidate TBSAs and recommend final TBSAs;

- Mill property investigation sampling and analysis results;
- Sediment characterization and geostatistical sampling pilot study;
- Floodplain soils and former impoundment sampling and analytical results;
- Surface water investigation results;
- Biota sampling results;
- Results of Phase II sediment sampling.

The technical memoranda will include:

- Description of the subject activities;
- A plot of actual sampling locations along with corresponding sample number;
- All sample identification information;
- Photocopies of all pertinent field notes;
- Description of geology, pertinent aspects, hydrology, etc.;
- Results of sampling analyses;
- Maps of figures presenting the areal and vertical distributions of constituents (constituent concentration profiles); and
- Preliminary findings and recommendations for subsequent activities as appropriate.

The technical memoranda will also present the QA/QC review of pertinent historical data proposed for use in the RI report.

### **5.5 Sample Analysis and Data Validation**

As explained in Section 5.3, the AOC requires the preparation of a FSP and a QAPP among other documents related to this RI/FS Work Plan. As such, a

FSP and a QAPP have been prepared and are submitted to MDNR each under separate cover.

Together these plans provide protocols and criteria related to sampling objectives, locations and frequency of proposed sampling, sampling and field procedures for each matrix of concern, sample handling and documentation, field QA/QC procedures (see FSP) as well as laboratory analytical and QA/QC procedures, sample and document custody procedures, data validation, and QA reporting (see QAPP).

#### **5.6 Baseline EA**

In accordance with the AOC, the baseline EA is the responsibility of MDNR. As the lead agency for this RI/FS, MDNR and their contractor will conduct the EA; although Blasland & Bouck will produce much of the data that will be used for the EA.

#### **5.7 Preliminary Remedial Technologies**

Preliminary remedial technologies are presented in Table 5-10. Sufficient detail will be developed for the preliminary remedial technologies to ensure that the RI will develop a database adequate for the evaluation of remedial alternatives during the FS. To satisfy this requirement, the summaries of data requirements for each remedial technology has been prepared and are indicated in Table 5-11.

## **5.8 Site Investigation Analysis**

### **5.8.1 Data Analysis**

An analysis and summary of all RI data will be prepared and presented to the MDNR in a draft RI Report. Any comments made by MDNR will be addressed in the final document. The results and data from the RI will be organized and presented in a logical manner to describe the relationships between the components of the Site investigations for each affected medium.

In addition to standard reporting of PCB results on an Aroclor basis, the digital files of high resolution PCB chromatographic data from Aquatec will be analyzed to assess congener distributions for all sample media. The congener distribution analysis will be based on the mass analysis of Aroclors on the same gas chromatography column by Aquatec and Schulz et al. (1989) (see Appendix C).

The data from the RI will be analyzed, and a summary of the type and extent of constituents at the NPL Site will be prepared. This information will include a description of the quantities and concentration of specific constituents at the Site and associated ambient levels. There will also be a description of the number, locations, and types of nearby populations, in addition to activities and exposure pathways that may result in an increased risk to public health, welfare, or the environment.

### **5.8.2 Application to Preliminary Technologies**

The data collected during the RI should be of sufficient quality and quantity to support the FS of potential remedial technologies (Table 5-10). The results of the RI will be analyzed in relation to the preliminary technologies developed in Section 5.7.2. Data supporting or rejecting the

various types of remedial technologies, compatibility of media with construction materials, and any other conclusions drawn will also be presented.

### **5.9 Remedial Investigation Report**

A draft report of the RI will be prepared and submitted to MDNR in accordance with the project schedule. The draft report shall include the results of the RI. Additional information will be included as an appendix to the draft report. A preliminary Table of Contents is presented below:

**Executive Summary**

**Section 1 - Introduction**

**Section 2 - Study Area Investigation**

**Section 3 - Physical Characteristics of the Study Area**

**Section 4 - Nature and Extent of Contamination**

**Section 5 - Contaminant Fate and Transport**

**Section 6 - Baseline Risk Assessment**

**Section 7 - Summary and Conclusion**

Any comments prepared by the MDNR regarding the draft report will be addressed in the final RI/FS Report. Upon MDNR's approval of the final RI/FS Report, five copies will be submitted to the MDNR.

### **5.10 Reporting Requirements**

Monthly reports will be prepared to describe the technical progress of the project. The following items will be discussed in such reports:

- Identification of RI/FS activities undertaken during the month;

- Status of work and progress to date, including all sampling, tests and, all other raw data produced during the reporting period;
- Percentage of completion;
- Difficulties encountered during the reporting period;
- Actions being taken to rectify problems;
- Activities planned for the next month; and
- Changes in personnel.

The monthly progress report will list target and actual completion dates for each element of activity, including project completion, and provide explanations for any deviations from the milestones in the Work Plan schedule. One copy of each of these reports will be sent to MDNR by the 21st day of the following month.

## **SECTION 6 - FS TASKS**

### **6.1 Introduction**

Included with the AOC is a SOW outlining the scope for the overall RI/FS.

The work tasks regarding the FS according to the SOW are:

- DCS and Proposed Response;
- Development of Alternatives;
- Initial Screening of Alternatives;
- Laboratory Treatability Studies;
- Evaluation of Alternatives;
- FS Reports; and
- Additional Requirements.

Details of these activities are provided in the following subsections.

### **6.2 DCS and Proposed Response**

The primary objective of the FS is to develop and evaluate remedial alternatives that may be appropriate as a remedy for the NPL Site. The FS requires information on NPL Site background, the nature and extent of the constituents of interest, and previous response activities. This requirement is summarized in Section 5.2 of this Work Plan.

Consistent with the NCP, CERCLA, Act 307, and various applicable state and federal guidelines, the FS for the NPL Site will be performed in three phases: 1) development of remedial alternatives; 2) initial screening of the remedial alternatives; and 3) detailed evaluation of the retained alternatives

deemed potentially viable during the screening study. Each phase is briefly described below (Sections 6.3 through 6.6).

### **6.3 Development of Alternatives**

Based on the results of the RI and consideration of preliminary remedial technologies (USEPA, 1988a, 1990a), the FS will develop remedial action alternatives.

Each of the remedial alternatives under consideration (Table 5-10) will be further subcategorized into one or more technologies or process options. As required by the NCP and AOC, the no-action alternative will also be considered. Potentially applicable technologies and process options for each remedial alternative will be screened for effectiveness, cost, and implementability as outlined in the NCP, Act 307, and USEPA guidance (1988a, 1990a). In conjunction with Table 5-10, the potential candidate technologies, which could be used in combinations within the various alternatives, are presented along with required data needs for the FS evaluation in Table 5-11. As the RI progresses, emerging technologies will be assessed and included as appropriate.

A preliminary list of potentially applicable remedial alternatives will be completed. The general remedial alternatives will be identified, based on a review of existing Site information. Further development of more Site-specific remedial alternatives will continue when the complete results of the RI and FS become available.

#### **6.3.1 Establishment of Remedial Action Objectives**

The preliminary remediation objectives shall be developed in consultation with the MDNR. The objectives will be based on:

- Public health and environmental issues;
- DCS;
- Information gathered during the RI;
- Section 300.430 of the NCP (RI/FS and selection of remedy);
- USEPA's "Guidance on Remedial Actions for Superfund Sites with PCB Contamination" (USEPA, 1990a);
- The requirements of ARARs as defined under Section 121 of the Superfund Amendment and Reauthorization Act of 1986 (SARA) including Act 307; and
- The reduction of risks (if any) associated with the constituents of interest.

#### 6.3.2 Remedial Alternatives

The potential alternatives for remediation will be developed by assessing technologies or combinations of technologies, and the media to which they would be applied, into alternatives that address constituents of interest. In particular, the development and screening of alternatives will include the following strategies:

- Development of remedial action objectives specifying the constituents and media of interest, potential exposure pathways, and preliminary remediation goals that permit a range of treatment and containment alternatives to be developed. The preliminary remediation goals will be developed on the basis of chemical-specific ARARs, NPL Site-specific risk-related factors, and other available information.

- Development of general response actions for each medium of interest defining containment, treatment, excavation, pumping, or other actions, singly or in combination, that may be taken in an effort to satisfy the remedial action objectives for the NPL Site.
- Identification of volumes or areas of media to which general response actions might be applied, taking into account the remedial action objectives and the chemical and physical characterization of the NPL Site.
- Identification and screening of the technologies applicable to each general response action to eliminate those which cannot be implemented technically at the NPL Site. The general response actions are further defined to specify remedial technology types (e.g., the general response action of treatment can be further defined to include chemical or biological technology types).
- Identification and evaluation of technology process options to select a representative process for each technology type retained for consideration. Although specific processes may be selected for alternative development and evaluation, these processes are intended to represent the broader range of process options within a general technology type.
- Assemblage of the selected representative technologies into alternatives representing a range of treatment and containment combinations, as appropriate.

#### 6.3.3 Additional Alternatives

Additional alternatives that will be developed are:

- An alternative that involves containment of residuals with little or no treatment, but provides increased protection of human health and the environment primarily by preventing potential exposure or reducing the mobility of the residuals;
- A no-action alternative; and
- Alternatives which also provide a performance range to meet Type A, B, and C cleanup goals in accordance with Act 307.

#### **6.4 Initial Screening of Alternatives**

##### **6.4.1 Description of Alternatives**

Screening will begin with a review of the potential remedial alternatives previously identified for the NPL Site. Consistent with the NCP, CERCLA Guidance (USEPA, 1988a, 1990a), and Act 307 on FS preparation, the initial list of technology types will be screened on the basis of technical implementability and effectiveness. This will be performed by assessing the physical and chemical characteristics of the NPL Site and eliminating those technologies which are determined not to be feasible, practical, or appropriate.

To simplify the subsequent detailed evaluation of potential remedial alternatives, CERCLA guidance (USEPA, 1988a, 1990a) will be followed to ensure that representative process options will be selected by comparing and screening technology-specific process options based on effectiveness and implementability. The specific focus of each criterion is highlighted below.

### Technical Effectiveness

The effectiveness of a specific technology process option is determined through consideration of the following:

- Ability of the process option to handle the volume of material being addressed;
- Ability of the process option to achieve the remedial action objectives;
- Potential impacts to human health and the environment during implementation/construction; and
- Experience with the technology and the degree of proven reliability.

Consistent with CERCLA guidance (USEPA, 1988a; 1990a), these criteria will be given a high level of consideration during this phase of the evaluation process.

### Implementability

When evaluating implementability, the technical and administrative feasibility of each option will be considered, with an emphasis on institutional controls such as the ability to obtain permits for off-site actions, and the commercial availability and requirements for such items as treatment, storage, disposal, capacity, specific equipment, technical support or specialists, and public perception. Administrative infeasibility alone, however, will not eliminate a remedial alternative from further consideration.

Following screening, the retained alternatives and process options will be assembled into a number of potentially viable NPL Site-specific remedial alternatives, which shall include the following:

- Treatment alternatives for source control that would eliminate the need for long-term management (including monitoring);
- Alternatives involving treatment as principal element to reduce the toxicity, mobility, or volume at the NPL Site.
- An alternative that involves containment with little or no treatment, but provides increased protection of human health and the environment primarily by preventing potential exposure or reducing mobility; and
- No-Action alternative.

#### 6.4.2 Alternatives Array Document

Following the preliminary screening of alternatives, a list of ARARs pertaining to the remaining remedial alternatives will be developed. In order to facilitate this development process, the alternatives array document will summarize the description of the NPL Site, technology identification and screening, and alternatives development and screening. The document will be submitted to the MDNR, which will then distribute it to appropriate sections and/or agencies for review and further clarification.

ARARs are generally placed in one of three broad categories (USEPA, 1988b). First, ambient or chemical-specific requirements, which are usually health- or risk-based, are based on certain established methodologies and require the establishment of numerical values for site-specific conditions. These values establish the amount or concentration of a constituent that may be found in, or discharged to, the ambient environment. Secondly, performance, design, or other action-specific requirements are usually technology- or activity-based. Thirdly, location-specific requirements place

restrictions on the concentration of constituents, or the conduct of remedial activities that might inadvertently release low levels of constituents.

### **6.5 Laboratory Treatability Studies**

The identification and execution of treatability studies usually occurs once the remedial alternatives screening process is complete. As stated in USEPA RI/FS guidance (USEPA, 1988a), the primary objectives of treatability studies are to:

- Provide sufficient data to allow an alternative(s) to be fully developed and evaluated during detailed analysis;
- Support the remedial design of selected alternative; and
- Provide information to reduce cost and performance uncertainties to allow selection of a remedy.

The objective of the approach to implementing laboratory treatability studies during the RI/FS is to reduce the chance that treatability studies will limit the schedule for completion of the RI/FS.

There are good reasons, however, for the sequence of undertaking treatability studies after a careful screening of technologies. One reason is that certain technologies will be screened from further consideration because they are inappropriate, infeasible, not proven, or known to be too costly. For example, a technology likely to fall into this category based upon current information is in-situ vitrification. Another reason is that the alternative development and screening process may indicate the need for testing of specific materials handling and treatment techniques that were either not identified or considered important at the outset of the process.

In general, laboratory treatability studies for extraction, stabilization, chemical destruction, and thermal destruction technologies for PCB-containing materials can be undertaken and completed in a five- to six-month period. However, biological treatability studies for PCB materials typically require a longer period of time. For anaerobic dechlorination, a year or more may be required.

Both aerobic and anaerobic biotreatability studies will be conducted using sediments from the Allied Paper, Inc. OU.

A commercial vendor working on the development of aerobic biotreatment technologies for PCBs will be requested to propose a specific treatability study design for their process. Anaerobic treatability studies will be conducted either by Blasland & Bouck, at their treatability laboratory or through subcontract with a commercial or research laboratory. In both studies, the ability to enhance endogenous activity, and, in the aerobic study, the effectiveness of bioaugmentation (application of PCB degrading bacteria isolated from another area) will be evaluated.

In addition to the results of bench-scale testing, the presence and extent of PCB biodegradation process in the Kalamazoo River sediments will be assessed using the results of PCB congener analyses as well as the chromatographic data from the USEPA SW-846 Method 8081 PCB analysis (USEPA, 1990c). Both analytical methods will use the same chromatography column. Evident variations in sediment PCB composition from PCB Aroclors will be assessed in light of the known influences of dissolution weathering processes upon PCB mixtures in the environment and the pattern of composition alteration produced by aerobic and anaerobic biodegradation processes.

Other laboratory treatability studies, as well as possible field studies, may be required to further evaluate the technology effectiveness and to establish engineering criteria. The actual scope of such studies will depend on the technologies identified for further evaluation. If additional laboratory studies are required, an addendum to the Work Plan will be prepared and submitted to MDNR for approval. This submittal will be made in a time frame such that steady progress of the overall FS is maintained to the extent possible. Additional studies may also be conducted during the design phase, if needed, to develop detailed design criteria. A report summarizing the testing program and its results will be prepared and submitted to MDNR.

## **6.6 Evaluation of Alternatives**

### **6.6.1 Evaluation of Alternatives**

The identified action-specific federal and state ARARs will be used in the analysis and selection of the remedy. The remedial alternatives will be analyzed in sufficient detail so that the remedy can be selected from a set of defined and discrete approaches. Included with the ARARs, a description of constituents of interest, the affected media, and any physical features that may help identify NPL Site-specific ARARs will be prepared.

The analysis of remedial alternatives under review shall reflect the scope and complexity of issues and alternatives being evaluated and consider the relative significance of the factors within each criteria. The nine evaluation criteria as defined in the NCP, are as follows:

- Overall protection of human health and the environment;
- Compliance with federal and state ARARs;

- Long-term effectiveness and permanence;
- Reduction in toxicity, mobility, and volume through treatment;
- Short-term effectiveness;
- Implementability;
- Cost-effectiveness;
- State acceptance; and
- Community acceptance.

#### **6.6.2 Comparison of Alternatives**

A comparison of the alternatives to each other, using the full array of evaluation factors appropriate at the NPL Site, will be made. The purpose of this comparative analysis is to identify the advantages and disadvantages of each alternative relative to one another so that key trade-offs can be identified.

Component measures of effectiveness include the degree to which the alternative increases protection of human health and the environment. Where health-based levels are established in ARARs, they will be used in establishing the remedial action objectives for the NPL Site. Where ARARs are not available, an EA conducted by MDNR will be used to help establish remedial action objectives appropriate for the NPL Site. The reliability of the remedy is another important element of effectiveness. Specific measures will also include other health risks borne by the potentially affected population, population sensitivities, and potential impacts on environmental receptors. Another important measure of effectiveness is the degree to which the mobility, toxicity, or volume of the constituents of interest is reduced.

Component measures of implementability include the technical feasibility of the alternative, the administrative feasibility of implementing the alternative, and the availability of any needed equipment, specialists, or off-Site capacity.

Component measures of cost include short-term capital and operation costs and any long-term operation or maintenance costs. Present worth analysis may be used to compare alternatives.

Component measures will be tailored appropriately to the NPL Site. Where the measures are likely to be important in discriminating among the alternatives, more emphasis and detail may be appropriate to assist in the selection of a remedy.

#### **6.6.3 Preferred Remedy**

The evaluation of alternatives to select the appropriate remedy will be performed so as to meet the requirements in Section 300.430(e)(g) of the NCP (Detailed Analysis of Alternatives) and to comply with Act 307.

### **6.7 FS Report**

Upon completion of the FS tasks associated with Sections 6.2 through 6.6, a draft report presenting the results of the FS will be submitted to the MDNR. A preliminary Table of Contents is presented below:

Executive Summary

Section 1 - Introduction

Section 2 - Identification and Screening of Technologies

Section 3 - Development and Screening of Alternatives

Section 4 - Detailed Analysis of Alternatives

**Section 5 - Comparative Evaluation of Remedial Alternatives**

**Section 6 - Summary and Conclusions**

After addressing MDNR's comments regarding the draft report, Blasland & Bouck will submit five copies of the final FS Report to MDNR to fulfill final project requirements.

**6.8 Additional Requirements**

Reporting requirements described in Section 5.10 will also be followed during the FS to communicate to the MDNR the progress of the technology screening process. In particular, technologies that have been screened and removed from further evaluation will be identified. This information will be summarized in the Alternative Array Document as described in Section 6.4.2.

## **SECTION 7 - COMMUNITY RELATIONS**

In order to achieve community understanding of the actions taken as well as to obtain community input and support prior to selection of the remedial alternative(s), a Community Relations Plan has been prepared by the MDNR (MDNR, 1991).

The plan describes the history of community concern and identifies proposed community relations activities to be implemented during the RI/FS. The plan integrates community relations with all remedial response activities. Whenever necessary, fact sheets concerning the NPL Site and related activities will be prepared and submitted to the MDNR for approval prior to being released to the public.

Blasland & Bouck will provide support to the community relations program as requested by MDNR and will represent the KRSG at all public meetings.

## SECTION 8 - SCHEDULE

Figure 21 presents the schedule for execution of the currently identified RI tasks for the Kalamazoo River/Portage Creek RI/FS. It is anticipated that the draft RI Report will be submitted three months after MDNR's approval of the last technical memorandum. As presently scoped, the last technical memorandum will be either the Biota Investigation Technical Memorandum or the Phase II Sediment Investigation Technical Memorandum (the latter is not shown on Figure 21).

The draft Alternatives Array Documents will be produced eight months after the final RI Report with the draft FS Report being produced six months after the final Alternatives Array Document.

The actual schedule will be influenced by a number of factors, and may thus require flexibility. Some important scheduling assumptions, qualifications and clarifications are presented below.

### Analytical Work Load

The schedule presented in Figure 21 assumes MDNR's approval of the Work Plan on July 1, 1993. The primary scheduling factor is the rate of sample production for PCB analysis resulting from the combination of the OU investigations and the investigations described in this Work Plan. The OU investigations will generate approximately 1,400 samples (including QA/QC samples) for PCB analysis within the first four months of field activities. This will leave little, if any, unused capacity at the laboratory for sample analysis within specified holding times during the first six months of the RI. As presently scoped (but not including the Phase II Sediment Sampling), this Work Plan will produce an additional 2,400 samples for PCB analysis. To assure that

samples will be analyzed within specified holding times and to avoid storage of biota samples in freezers, several activities, which could otherwise be undertaken during the first six months, have been scheduled for the second year. The geostatistical sampling pilot study will be conducted early in the RI to assist the determination of Phase II Sediment Sampling.

#### Mobilization of Field Activities

The prior version of the Work Plan provided for one-month of mobilization time. However, with certain qualifications as described below, that time has been eliminated because certain mobilization activities have been undertaken in June 1993 prior to Work Plan approval. A one-month mobilization period upon work plan approval still would be necessary to assure that Blasland & Bouck meets the requirements in the AOC (Paragraph 25) that "The Respondents shall notify MDNR not less than four (4) weeks in advance of any sample collection activity. Not less than three weeks in advance of sample collection, the Respondents shall notify MDNR of the sampling date, sampling media, the number of samples from each media unless MDNR specifies a different time period." Unless MDNR waives this requirement or considers that the schedule provided in this document and other information communicated to MDNR satisfy this requirement, a one-month mobilization time will be required. Progress of mobilization and preparatory work during the period of public and agency review of the Work Plan will be communicated to MDNR's Project Manager by Blasland & Bouck. In addition, if work plan approval is not provided by July 1, 1993, some remobilization time will need to be added to the initial part of the schedule. Furthermore, it may be necessary to reschedule certain activities to the 1994 field season if initiation of work is delayed beyond July 1, 1993.

#### Analytical Turnaround

The rate of sample production from the simultaneous investigations of four OUs and the Site will bring the subcontract laboratory near to its capacity to analyze samples for a significant period. The laboratory intends to meet the 30-day turnaround time to be specified in its contract and to produce consistently valid results. However, based upon general experience in such large projects we have assumed, for planning purposes, 60 days for sample analysis, QA/QC review, and the resolution of QA/QC problems. This, however, does not include time for resampling if necessary. Any resampling will extend the schedule.

#### Surface Water Investigation

The base-flow surface water sampling is intended for the summer and early autumn period. The high-flow event sampling is dependent on hydrologic conditions. Conditions are generally most favorable to high sustained flows during the spring. Considering the expected amount of time required by MDNR to approve the Work Plan, it is likely that high-low event sampling will be completed in spring 1994.

#### Phase II Sediment Sampling

The scope and duration of Phase II sediment sampling is controlled by the results of Phase I sediment sampling and the Geostatistical Sampling Pilot Study. MDNR will provide guidance on the Scope of Work pursuant to Phase II. Hence, the schedule will be extended based on the duration of Phase II Sampling and other sampling activities.

## EA

The schedule assumes that the EA will be produced by MDNR at least ten weeks prior to the submittal of the Alternative Array Document. If the EA is delayed beyond this time frame, the schedule will be extended.

### Technical Memoranda Submittals

During the course of the RI a series of technical memorandums will be prepared and submitted to MDNR, presenting a preliminary interpretation of the results of various aspects of the RI.

The production of the draft RI Report is contingent upon MDNR approval of the Technical Memoranda.

### Changes in Investigation Scope

Changes in RI/FS work scope prior to commencement, or during the RI as may be appropriate or required, would have an impact on the schedule. Any increases in scope of work will extend the schedule.

### Weather/Site Conditions

A number of tasks are either weather, temperature, flow, and/or access dependent. The actual schedule may, therefore, change to accommodate these constraints. If weather conditions prohibit collection of field data, the schedule will be extended.

The above represent some, but not necessarily all, of the schedule influencing factors and considerations. Schedules may be extended by unforeseeable events and events over which the KRSG has no control.

## **SECTION 9 - PROJECT MANAGEMENT**

### **9.1 Project Organization**

Blasland & Bouck will be responsible for conducting the Work Plan tasks on behalf of the KRSB. The organizational chart for the Work Plan activities conducted by Blasland & Bouck, is presented in Figure 22. Mark P. Brown, Ph.D., a Vice-President at Blasland & Bouck, will serve as the Project Coordinator for the RI/FS and for technical communications regarding the RI/FS between MDNR and the KRSB. Technical advisors to Dr. Brown are Robert K. Goldman, P.E., and Dawn S. Foster, P.E. of Blasland & Bouck. Gregory W. Peterson of Limno-Tech, Inc. will provide technical advice to the Project Coordinator. Other key individuals and their responsibilities are described below.

Scott T. Saroff, C.P.G., Manager at Blasland & Bouck, will serve as Project Manager and will be responsible for the execution of the RI/FS tasks.

Patrick N. McGuire, a Manager of engineering at Blasland & Bouck, will be responsible for the remedial alternatives evaluation and the treatability testing in support of the FS.

Richard P. DiFiore, a Manager of Field Services at Blasland & Bouck, will be responsible for the collection of soil and sediment samples and the operation of the field office. Gregg A. Rabasco and Penelope Thompson Rabasco will assist Mr. DiFiore in the collection of soil and sediment samples. Staff of Limno-Tech, Inc. under the direction of Gregory W. Peterson will provide field support during the RI.

All the land surveying will be conducted under the direction of Terry H. Young, L.S., of Blasland & Bouck.

David W. Hohreiter, Ph.D., a Manager of Toxicology at Blasland & Bouck, will be responsible for biota investigations, collection of data to characterize potentially exposed populations, and the analysis of RI data to assist the EA.

Subcontractors to Blasland & Bouck, will be necessary to perform certain RI/FS support services such as analytical services and geotechnical services.

An MDNR contractor will oversee the conduct of the RI/FS on behalf of MDNR. Senior project management staff at Blasland & Bouck will work with MDNR's contractor to facilitate overall coordination of field activities. Day-to-day coordination for field sampling activities will be performed by Richard DiFiore and his counterpart(s) with MDNR's contractor.

## **9.2 Site Office**

The site office will be established in the Kalamazoo Area. The following requirements will be met:

- Safe and secure area;
- Parking with adequate capacity for federal and state employees;
- Sanitary facilities;
- Telephone with multiple lines and with long distance service;
- Storage space;
- Electric power, heat and adequate ventilation ; and
- Facsimile machine.



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# **Acronyms and Abbreviations**

**ACRONYMS AND ABBREVIATIONS**

Act 307	Michigan Environmental Response Act
AOC	Administrative Order by Consent
ARARs	Applicable or Relevant and Appropriate Requirements
ASTM	American Society for Testing and Materials
ATSDR	Agency for Toxic Substances and Disease Registry
Be-7	Beryllium-7
Blasland & Bouck	Blasland & Bouck Engineers, P.C.
BOD	Biochemical Oxygen Demand
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act of 1980 as amended by SARA in 1986, also known as Superfund
cfs	Cubic Feet Per Second
CFR	Code of Federal Regulations
CLP TCL/TAL	Contract Laboratory Program Target Compound List/Target Analyte List
Cs-137	Cesium-137
DCS	Description of the Current Situation
DMP	Data Management Plan
DQOs	Data Quality Objectives
EA	Endangerment Assessment
EMSL	Environmental Monitoring System Laboratory
FDA	Food and Drug Administration
FEMA	Federal Emergency Management Agency
FGETs	Food and Gill Exchange of Toxic Substances
FS	Feasibility Study
FSP	Field Sampling Plan
GeoEAS	Geostatistical Environmental Assessment Software
HRDL	Historical Residuals Disposal Lagoon
HSP	Health & Safety Plan
IJC	International Joint Commission
KRSG	Kalamazoo River Study Group
MDNR	Michigan Department of Natural Resources
MDPH	Michigan Department of Public Health
mg/kg	Milligram per kilogram
MS/MSD	Matrix Spike/Matrix Spike Duplicate
MWRC	Michigan Water Resources Commission
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NOAA	National Oceanic and Atmospheric Administration
NPL	National Priorities List
NPL Site	Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund Site
NWI	National Wetlands Inventory
OSHA	Occupational Safety and Health Administration
OU	Operable Unit
PCBs	Polychlorinated biphenyls
PCDDs	Polychlorinated dibenzo-p-dioxins
PCDFs	Polychlorinated dibenzofurans
PID	Photoionization Detector

**ACRONYMS AND ABBREVIATIONS**  
(cont'd)

QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
QA/QC	Quality Assurance/Quality Control
QA/QC-RHSDP	Quality Assurance/Quality Control Review of Historical Studies and Data Plan
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
RI/FFS	Remedial Investigation/Focused Feasibility Study
ROD	Record of Decision
SARA	Superfund Amendment and Reauthorization Act of 1986
SOW	Statement of Work
SS	Suspended Solids
SVOC	Semivolatile Organic Compounds
TBSAs	Terrestrial Biological Sampling Areas
TOC	Total Organic Carbon
TSS	Total Suspended Solids
ug/l	Micrograms per liter
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
VOC	Volatile Organic Compound
WASP4	Water Quality Analysis Program Version 4.3
WWTP	Wastewater Treatment Plant



## Tables

Table 2-1

Allied Paper, Inc./Portage Creek/Kalamazoo River  
Superfund Site

RI/FS Work Plan

Portage Creek and Kalamazoo River Physical Characteristics

Segment	Length (miles)	Average Width (ft.)	Average Depth (ft.)
Portage Creek - Alcott Street to Confluence with Kalamazoo River	1.2	16	2.0
Kalamazoo River - Morrow Lake Dam to Confluence with Portage Creek	4.0	40	2.5
Kalamazoo River - Portage Creek Confluence to Main Street, Plainwell	14.3	140	3.8
Kalamazoo River - Main Street, Plainwell to Plainwell Dam	2.0	230	3.3
Kalamazoo River - Plainwell Dam to Otsego City Dam	1.7	270	3.8
Kalamazoo River - Otsego City Dam to Otsego Dam	3.3	250	3.9
Kalamazoo River - Otsego Dam to Trowbridge Dam	4.0	320	4.3
Kalamazoo River - Trowbridge Dam to City Line of Allegan	7.3	230	4.6
Kalamazoo River - City Line of Allegan to Allegan City Dam	1.7	690	6.2
Kalamazoo River - Allegan City Dam to Lake Allegan Dam	10.5	1010	11
Kalamazoo River - Lake Allegan Dam to Lake Michigan	28	180	8.5

Reference:  
MDNR, 1987b.

TABLE 2-2  
Allied Paper, Inc./Portage Creek/Kalamazoo River  
Superfund Site  
RI/FS Work Plan  
Summary of Sediment PCB Data

Segment	Study Date	Number of Samples	Concentration Range (mg/kg)	Distribution of Data (Percent)		
				<10 mg/kg	10-50 mg/kg	>50 mg/kg
Portage Creek - Alcott Street to the Kalamazoo River Confluence	1972-1983	16	<1-120	19	56	25
Kalamazoo River - Morrow Lake Dam to Portage Creek Confluence	1976-1982	4	<1-7.7	100	0	0
Kalamazoo River - Portage Creek to Main Street, Plainwell	1976-1986	15	<1-57	73	20	7
Kalamazoo River - Main Street, Plainwell to Plainwell Dam	1976-1985	64	<1-56	79	19	2
Kalamazoo River - Plainwell Dam to Otsego City Dam	1982-1991	14	<1-181	64	21	14
Kalamazoo River - Otsego City Dam to Otsego Dam	1976-1984	36	<1-67	78	19	3
Kalamazoo River - Otsego Dam to Trowbridge Dam	1982-1988	105	<1-81	72	20	8
Kalamazoo River - Trowbridge Dam to Allegan City Dam	1982-1985	19	<1-57	37	58	5
Kalamazoo River - Allegan City Dam to Lake Allegan Dam	1976-1987	15	0.67-42	13	87	0
Kalamazoo River - Lake Allegan Dam to Lake Michigan	1982-1985	34	<1-1.7	100	0	0
Total Study Area	1972 - 1991	322	<1-181	70	25	6

Reference:  
Blasland & Bouck, 1992

TABLE 2-3

Allied Paper, Inc./Portage Creek/Kalamazoo River  
Superfund Site

RI/FS Work Plan

Summary of Recent Water-Column PCB Data

Segment	Study Date	Number of Samples	Concentration Range (ug/l)	Distribution of Data (Percent)		
				<0.1 ug/l	0.1-0.5 ug/l	>0.5 ug/l
Portage Creek - Alcott Street to the Kalamazoo River Confluence	1985-1991	52	<0.01-0.34	56	44	0
Kalamazoo River - Morrow Lake Dam to Portage Creek	1985-1988	37	<0.01-0.14	97	3	0
Kalamazoo River - Portage Creek to Main Street, Plainwell	1985-1987	21	<0.01-0.044	100	0	0
Kalamazoo River - Main Street, Plainwell to Plainwell Dam	1985-1986	14	<0.031-0.15	86	14	0
Kalamazoo River - Plainwell Dam to Otsego City Dam	---	0	---	---	---	---
Kalamazoo River - Otsego City Dam to Otsego Dam	1985	8	0.046-0.12	88	12	0
Kalamazoo River - Otsego Dam to Trowbridge Dam	---	0	---	---	---	---
Kalamazoo River - Trowbridge Dam to Allegan City Dam	1985	9	0.043-0.13	44	56	0
Kalamazoo River - Allegan City Dam to Lake Allegan Dam	1985-1986	12	0.057-0.19	33	67	0
Kalamazoo River - Lake Allegan Dam to Lake Michigan	1985-1988	17	<0.030-0.17	47	53	0
Total Study Area	1985-1991	170	<0.01-1.3	71	29	0

Reference:  
Blasland & Bouck, 1992

Table 2-4

Allied Paper, Inc./Portage Creek/Kalamazoo River  
Superfund Site

RI/FS Work Plan

Summary of Carp PCB Data 1985 to 1990

Location	Year	No. of Samples	PCBs (mg/kg)			
			Minimum	Maximum	Mean	Median
Ceresco Lake	1987 <sup>2</sup>	9	0.04	0.24	0.12	0.11
Morrow Lake	1985 <sup>1</sup>	27	0.39	8.9	2.2	2.1
	1986 <sup>1</sup>	20	0.60	13	2.5	2.1
	1987 <sup>2</sup>	9	0.26	5.8	1.4	0.75
Mosel Ave.	1985 <sup>1</sup>	19	1.0	6.4	3.4	3.5
Former Plainwell Dam Impoundment	1985 <sup>1</sup>	21	1.6	13	5.0	4.2
	1986 <sup>1</sup>	21	0.5	9.5	4.1	3.8
	1987 <sup>2</sup>	9	1.2	17	5.2	3.5
Otsego City Dam Impoundment	1985 <sup>1</sup>	12	0.40	3.9	2.0	1.8
Lake Allegan	1985 <sup>1</sup>	19	1.0	11	3.0	2.2
	1986 <sup>1</sup>	81	0.09	24	4.3	3.2
	1987 <sup>2</sup>	10	1.2	6.1	3.2	2.7
	1990 <sup>4</sup>	20	1.4	26	7.9	5.9
Saugatuck	1985 <sup>1</sup>	20	0.18	6.4	2.1	5.0

References:

- <sup>1</sup>NUS, 1986
- MDNR, 1987a
- <sup>2</sup>MDNR, 1989c
- <sup>3</sup>MDNR, 1985
- <sup>4</sup>Waggoner, 1991

Table 4-1

Allied Paper, Inc./Portage Creek/Kalamazoo River  
Superfund Site

RI/FS Work Plan

USEPA Contract Laboratory Program-Target Compound List/Target Analyte List

**TARGET COMPOUND LIST**

Volatile Compounds

acetone	chloromethane	methylene chloride
benzene	dibromochloromethane	4-methyl-2-pentanone
bromodichloromethane	1,1-dichloroethane	styrene
bromoform	1,2-dichloroethane	1,1,2,2-tetrachloroethane
bromomethane	1,1-dichloroethene	tetrachloroethene
2-butanone	1,2-dichloroethene (total)	toluene
carbon disulfide	1,2-dichloropropane	1,1,1-trichloroethane
carbon tetrachloride	cis-1,3-dichloropropene	1,1,2-trichloroethane
chlorobenzene	trans-1,3-dichloropropene	trichloroethene
chloroethane	ethylbenzene	vinyl chloride
chloroform	2-hexanone	xylenes (total)

Semivolatile Compounds

acenaphthene	dibenz(a,h)anthracene	hexachloroethane
acenaphthylene	dibenzofuran	indeno(1,2,3-cd)pyrene
anthracene	di-n-butylphthalate	isophorone
benzo(a)anthracene	1,2-dichlorobenzene	2-methylnaphthalene
benzo(b)fluoranthene	1,3-dichlorobenzene	2-methylphenol
benzo(k)fluoranthene	1,4-dichlorobenzene	4-methylphenol
benzo(g,h,i)perylene	3,3'-dichlorobenzidine	naphthalene
benzo(a)pyrene	2,4-dichlorophenol	2-nitroaniline
4-bromophenyl phenyl ether	diethyl phthalate	3-nitroaniline
butyl benzyl phthalate	2,4-dimethylphenol	4-nitroaniline
carbazole	4,6-dinitro-2-methyl phenol	nitrobenzene
4-chloroaniline	dimethyl phthalate	2-nitrophenol
bis(2-chloroethoxy)methane	2,4-dinitrophenol	4-nitrophenol
bis(2-chloroethyl)ether	2,4-dinitrotoluene	n-nitrosodiphenylamine
4-chloro-3-methyl phenol	2,6-dinitrotoluene	n-nitroso-di-n-propylamine
2-chloronaphthalene	di-n-octyl phthalate	pentachlorophenol
2-chlorophenol	bis(2-ethylhexyl)phthalate	phenanthrene
4-chlorophenyl phenyl ether	fluoranthene	phenol
2,2'-oxybis(1-chloropropane)	fluorene	pyrene
chrysene	hexachlorobenzene	1,2,4-trichlorobenzene
	hexachlorobutadiene	2,4,5-trichlorophenol
	hexachlorocyclopentadiene	2,4,6-trichlorophenol

(See References on Page 2)

Table 4-1  
(Cont'd)

Allied Paper, Inc./Portage Creek/Kalamazoo River  
Superfund Site

RI/FS Work Plan

USEPA Contract Laboratory Program-Target Compound List/Target Analyte List

Pesticides/PCB Compounds

aldrin	beta-BHC	endosulfan I
alpha-BHC	gamma-BHC (lindane)	endosulfan II
Aroclor - 1016	delta-BHC	endosulfan sulfate
Aroclor - 1221	alpha-chlordane	endrin
Aroclor - 1232	gamma-chlordane	endrin aldehyde
Aroclor - 1242	4,4'-DDD	endrin ketone
Aroclor - 1248	4,4'-DDE	heptachlor
Aroclor - 1254	4,4'-DDT	heptachlor epoxide
Aroclor - 1260	dieldrin	methoxychlor
		toxaphene

**TARGET ANALYTE LIST**

Metals/Other Compounds

aluminum	cobalt	nickel
antimony	copper	potassium
arsenic	cyanide	selenium
barium	iron	silver
beryllium	lead	sodium
cadmium	magnesium	thallium
calcium	manganese	vanadium
chromium	mercury	zinc

References:

TCL: USEPA, 1991b.  
TAL: USEPA, 1991c.

Table 4-3  
Allied Paper, Inc./Portage Creek/Kalamazoo River  
Superfund Site  
RI/FS Work Plan  
Water Data Quality Objectives

Data Type	Investigation Objectives	Data Quality Level <sup>1</sup>	Data Use(s) <sup>2</sup>
TARGET CONSTITUENTS			
Total PCBs	Identify PCB concentrations for various river conditions	IV equiv. III II	RA, SC RA, SC RA, SC
Dissolved PCBs	Access "dissolved"-phase PCB concentrations	IV equiv. III II	RA, SC RA, SC SC
CLP TCL	Determine the presence of organic constituents other than PCBs	IV	SC
CLP TAL	Determine the presence of inorganic constituents	IV	SC
SUPPLEMENTAL PARAMETERS			
TSS	Estimate suspended solids transport	III	SC, EA, ED
pH	Characterize general water quality	I	SC
Specific Conductance	Characterize general water quality	IV	SC

Table 4-4  
Allied Paper, Inc./Portage Creek/Kalamazoo River  
Superfund Site  
RI/FS Work Plan  
Sediment/Soil/Paper Making Residuals  
Data Quality Objectives

Data Type	Investigation Objectives	Data Quality Level <sup>1</sup>	Data Use(s) <sup>2</sup>
TARGET CONSTITUENTS			
PCBs	<ul style="list-style-type: none"><li>- Define extent of PCBs</li><li>- Determine boundaries of affected areas</li><li>- Identify concentration ranges present</li><li>- Estimate mass of PCBs at site</li><li>- Evaluate human health risks</li><li>- High resolution chromatograms will be used to address variations in PCB sources and environmental alterations</li></ul>	IV equiv. III II I	RA, SC, EA, ED RA, SC, EA, ED RA, SC, EA, ED RA, SC
CLP TCL	<ul style="list-style-type: none"><li>- Determine the presence of organic constituents other than PCBs</li></ul>	IV	SC
CLP TAL	<ul style="list-style-type: none"><li>- Determine the presence of inorganic constituents concern</li></ul>	IV	SC
PCDDs/PCDFs	<ul style="list-style-type: none"><li>- Determine the presence of PCDDs/PCDFs</li></ul>	IV equiv.	SC
SUPPLEMENTAL PARAMETERS			
Total Organic Carbon	<ul style="list-style-type: none"><li>- Aid in the "normalization" of PCB concentration and the assessment of gradients in bioavailable PCB concentrations</li></ul>	III	SC, ED
Radioisotopes	<ul style="list-style-type: none"><li>- Use as a chronostratigraphic marker</li><li>- Identify historic and current sediment deposition trends (1954 to present)</li><li>- Infer historic and current chemical deposition trends</li></ul>	III	SC

RI/FS Work Plan

Sediment/Soil/Paper Making Residuals  
Data Quality Objectives

Data Type	Investigation Objectives	Data Quality Level <sup>1</sup>	Data Use(s) <sup>2</sup>
PHYSICAL PARAMETERS			
One-Dimensional Consolidation Test	<ul style="list-style-type: none"><li>- Estimate deformation characteristics of media</li><li>- Determine stability of dikes</li></ul>	III	EA, ED
Particle Size Analysis	<ul style="list-style-type: none"><li>- Characterize depositional environments</li><li>- Evaluate physical characteristics of media</li><li>- Investigate possible correlation of particle size with chemical concentrations. (Fine particles are generally associated with low flow/deposition and are considered likely media for chemicals which tend to sorb to these materials)</li></ul>	III	EA, ED, SC
Moisture Content	<ul style="list-style-type: none"><li>- Evaluate physical characteristics of media</li></ul>	III	EA, ED, SC
Triaxial Compression	<ul style="list-style-type: none"><li>- Evaluate strength characteristics of media</li></ul>	III	EA, ED
Unconfined Compression Strength	<ul style="list-style-type: none"><li>- Evaluate strength characteristics of media</li></ul>	III	EA, ED
Direct Shear Test	<ul style="list-style-type: none"><li>- Evaluate strength characteristics of media</li></ul>	III	EA, ED
Bulk Density	<ul style="list-style-type: none"><li>- Evaluate physical characteristics of media</li></ul>	III	EA, ED
Cone Penetration Test	<ul style="list-style-type: none"><li>- Evaluate strength characteristics of media</li></ul>	III	EA, ED

Notes:

- 1

Data Quality Levels

IV equiv.

III

II

I

Analysis using USEPA SW-846 Methods with CLP type documentation

Laboratory analysis using methods other than CLP, without CLP documentation

General laboratory or field analysis

Field screening
- 2

Data Uses

SC

EA

ED

Site Characterization

Evaluation of remedial alternatives

Engineering design of alternative

Table 5-1

Allied Paper, Inc./Portage Creek/Kalamazoo River  
Superfund Site

RI/FS Work Plan

RI Samples - Sediment and Floodplain Soils Investigation

Study Activity	Sample Media	Sample Location <sup>1</sup>	Type of Analysis <sup>2</sup>	No. of Sampling Points	No. of Samples	RI Data Collection Objectives <sup>3</sup>
In-Stream Sediment Probing and Characterization	river/creek sediment	Portage Creek Alcott Street to Confluence	<ul style="list-style-type: none"><li>• sediment depth</li><li>• lithology description</li><li>• position/elevation</li><li>• visual reconnaissance of river</li><li>• velocity (20 to 25% of transects)</li><li>• upper 4" retained for possible future analysis</li></ul>	15 transects	—	5
		Segment 1		54 transects	—	
		Segment 2		12 transects	—	
		Segment 3		12 transects	—	
		Segment 4		15 transects	—	
		Segment 5		15 transects	—	
		Segment 6		17 transects	—	
		Segment 7		15 transects	—	
		Segment 8		19 transects	—	
		Segment 9		12 transects	—	
Geostatistical Pilot Study	river sediment	1-mile stretch between Otsego Dam and Trowbridge Dam	<ul style="list-style-type: none"><li>• PCBs</li><li>• sediment depth</li><li>• lithology description</li><li>• position/elevation</li></ul>	62	124	2

Table 5-1  
(cont'd)

Allied Paper, Inc./Portage Creek/Kalamazoo River  
Superfund Site

RI/FS Work Plan

RI Samples - Sediment and Floodplain Soils Investigation

Study Activity	Sample Media	Sample Location <sup>1</sup>	Type of Analysis <sup>2</sup>	No. of Sampling Points	No. of Samples	RI Data Collection Objectives <sup>3</sup>
Exposed Former Impoundment Sediment Sampling	soil/sediment	Former Plainwell Impoundment	• PCBs • lithology description • position/elevation	6 transects with 5 cores each	120	1,2,3,4,5,6
			• TOC		60	
			• CLP TCL/TAL	1 core	2	
			• Physical characterization <sup>5</sup>	3 cores	18	
		Former Otsego Impoundment	• PCBs • lithology description • position/elevation	6 transects with 5 cores each	120	
			• TOC	1 core	60	
			• CLP TCL/TAL	1 core	2	
			• Physical characterization <sup>5</sup>	3 cores	18	
		Former Trowbridge Impoundment	• PCBs • lithology description • position/elevation	9 transects with 6 points each	288	1,2,3,4,5,6
			• TOC		144	
			• CLP TCL/TAL	1 core	2	
			• Physical characterization <sup>5</sup>	3 cores	18	

Table 5-1  
(cont'd)  
Allied Paper, Inc./Portage Creek/Kalamazoo River  
Superfund Site  
RI/FS Work Plan  
RI Samples - Sediment and Floodplain Soils Investigation

Study Activity	Sample Media	Sample Location <sup>1</sup>	Type of Analysis <sup>2</sup>	No. of Sampling Points	No. of Samples	RI Data Collection Objectives <sup>3</sup>
Floodplain Soil Sampling	soils	Upjohn Park (adjacent to Portage Creek)	<ul style="list-style-type: none"><li>• PCBs</li><li>• lithology description</li><li>• position/elevation</li></ul>	1 transect with 5 points	12	2.6
			<ul style="list-style-type: none"><li>• TOC</li></ul>		5	
		Portage Paper Mill Property (adjacent to Portage Creek)	<ul style="list-style-type: none"><li>• PCBs</li><li>• lithology description</li><li>• position/elevation</li></ul>	5 random locations	12	
			<ul style="list-style-type: none"><li>• TOC</li></ul>		5	
		Verburg Park	<ul style="list-style-type: none"><li>• PCBs</li><li>• lithology description</li><li>• position/elevation</li></ul>	1 transect with 8 points	16	
			<ul style="list-style-type: none"><li>• TOC</li></ul>		8	
			<ul style="list-style-type: none"><li>• CLP TCL/TAL</li></ul>	1 core	2	
		South of D Avenue	<ul style="list-style-type: none"><li>• PCBs</li><li>• lithology description</li><li>• position/elevation</li></ul>	1 transect with 8 cores	16	
			<ul style="list-style-type: none"><li>• TOC</li></ul>		8	
			<ul style="list-style-type: none"><li>• CLP/TCL/TAL</li></ul>	1 core	2	
		Brookside Park	<ul style="list-style-type: none"><li>• PCBs</li><li>• lithology description</li><li>• position/elevation</li></ul>	1 transect with 8 cores	16	
			<ul style="list-style-type: none"><li>• TOC</li></ul>		8	
			<ul style="list-style-type: none"><li>• CLP TCL/TAL</li></ul>	1 core	2	

Table 5-1  
(cont'd)  
Allied Paper, Inc./Portage Creek/Kalamazoo River  
Superfund Site  
RI/FS Work Plan  
RI Samples - Sediment and Floodplain Soils Investigation

Study Activity	Sample Media	Sample Location <sup>1</sup>	Type of Analysis <sup>2</sup>	No. of Sampling Points	No. of Samples	RI Data Collection Objectives <sup>3</sup>
Floodplain Soil Sampling (cont'd)	soils (cont'd)	Former Otsego Dam Impoundment	<ul style="list-style-type: none"><li>• PCBs</li><li>• lithology description</li><li>• position/elevation</li></ul>	1 transect with 8 cores	18	2,6
			<ul style="list-style-type: none"><li>• TOC</li></ul>		8	
			<ul style="list-style-type: none"><li>• CLP TCL/TAL</li></ul>	1 core	2	
		Downstream of Trowbridge Dam	<ul style="list-style-type: none"><li>• PCBs</li><li>• lithology description</li><li>• position/elevation</li></ul>	1 transect with 8 cores	18	
			<ul style="list-style-type: none"><li>• TOC</li></ul>		8	
			<ul style="list-style-type: none"><li>• CLP TCL/TAL</li></ul>	1 core	2	

Table 5-1  
(cont'd)  
Allied Paper, Inc./Portage Creek/Kalamazoo River  
Superfund Site  
RI/FS Work Plan  
RI Samples - Sediment and Floodplain Soils Investigation

Study Activity	Sample Media	Sample Location <sup>1</sup>	Type of Analysis <sup>2</sup>	No. of Sampling Points	No. of Samples	RI Data Collection Objectives <sup>3</sup>
Floodplain Soil Sampling (cont'd)	soils	Koopman Marsh/ Swan Creek Marsh	<ul style="list-style-type: none"><li>PCBs</li><li>lithology description</li><li>position/elevation</li></ul>	3 transects with 5 cores	45	2,6
			<ul style="list-style-type: none"><li>TOC</li></ul>		15	
		Ottawa Marsh	<ul style="list-style-type: none"><li>PCBs</li></ul>	3 cores	14	
			<ul style="list-style-type: none"><li>CLP TCL/TAL</li></ul>		1	
		Pottowatamie Marsh	<ul style="list-style-type: none"><li>PCBs</li></ul>	3 cores	14	
			<ul style="list-style-type: none"><li>CLP TCL/TAL</li></ul>		1	
Endangerment Assessment Soil Sampling <sup>4</sup>	soils	Fl. Custer State Recreation Area	<ul style="list-style-type: none"><li>PCBs</li></ul>	3 6-sample composites	3	6
		Former Plainwell Dam Impoundment	<ul style="list-style-type: none"><li>PCBs</li></ul>	6 6-sample composites	6	
		Downstream of Plainwell Dam	<ul style="list-style-type: none"><li>PCBs</li></ul>	3 6-sample composites	3	
		Pine Creek Impoundment	<ul style="list-style-type: none"><li>PCBs</li></ul>	3 6-sample composites	3	

Table 5-1  
(cont'd)

Allied Paper, Inc./Portage Creek/Kalamazoo River  
Superfund Site

RI/FS Work Plan

RI Samples - Sediment and Floodplain Soils Investigation

Study Activity	Sample Media	Sample Location <sup>1</sup>	Type of Analysis <sup>2</sup>	No. of Sampling Points	No. of Samples	RI Data Collection Objectives <sup>3</sup>
EA Soil Sampling (cont'd)	soils (cont'd)	Former Otsego Dam Impoundment	• PCBs	6 6-sample composites	6	6
		Former Trowbridge Dam Impoundment	• PCBs	12 6-sample composites	12	
		Koopman Marsh	• PCBs	3 6-sample composites	3	
Geochronological Dating Sampling <sup>3</sup>	lake sediments	Allegan City Dam Impoundment	• Cs-137 • lithology description • position/elevation	2 cores	12	2,3,5,6
		Kalamazoo Lake	• Cs-137 • lithology description • position/elevation	2 cores	12	

Table 5-1  
(cont'd)

Allied Paper, Inc./Portage Creek/Kalamazoo River  
Superfund Site

RI/FS Work Plan

RI Samples - Sediment and Floodplain Soils Investigation

Study Activity	Sample Media	Sample Location <sup>1</sup>	Type of Analysis <sup>2</sup>	No. of Sampling Points	No. of Samples	RI Data Collection Objectives <sup>3</sup>
Source Identification	river sediments	Tributary to Morrow Lake	<ul style="list-style-type: none"><li>• PCBs</li><li>• TOC (0 to 6%)</li><li>• lithology description</li><li>• sediment depth</li><li>• water depth</li><li>• position</li></ul>	1	6	2.4
		Segment 1		8	48	
		Segment 2		1	6	
		Segment 3		1	6	
		Segment 4		2	12	
		Segment 5		1	6	
		Segment 6		1	6	
		Segment 8		1	6	

Table 5-1  
(cont'd)

Allied Paper, Inc./Portage Creek/Kalamazoo River  
Superfund Site

RI/FS Work Plan

RI Samples - Sediment and Floodplain Soils Investigation

Notes:

<sup>1</sup>Kalamazoo River Segments:

- Segment 1 - Morrow Lake Dam to Main Street Plainwell
- Segment 2 - Main Street Plainwell to Plainwell Dam
- Segment 3 - Plainwell Dam to Otsego City Dam
- Segment 4 - Otsego City Dam to Otsego Dam
- Segment 5 - Otsego Dam to Trowbridge Dam
- Segment 6 - Trowbridge Dam to Allegan City Line
- Segment 7 - Allegan City Line to Allegan City Dam
- Segment 8 - Allegan City Dam to Lake Allegan Dam
- Segment 9 - Lake Allegan Dam to Lake Michigan

<sup>2</sup>Abbreviations used in this table:

- PCBs - Polychlorinated biphenyls
- CLP TCL/TAL - Contract Laboratory Program Target Compound List/Target Analyte List
- TOC - Total organic carbon
- Cs-137 - Cesium-137

Table 5-1  
(cont'd)

Allied Paper, Inc./Portage Creek/Kalamazoo River  
Superfund Site

RI/FS Work Plan

RI Samples - Sediment and Floodplain Soils Investigation

Notes (Cont'd)

<sup>3</sup>RI Data Collection Objectives:

1. Characterize chemical nature of wastes at the site.
2. Determine the spatial distribution of chemicals.
3. Identify chemical migration pathways and movement.
4. Identify sources.
5. Support the evaluation of remedial alternatives.
  - a. Assess the technical feasibility of an alternative (e.g., material characteristics).
  - b. Assess the effectiveness of potential alternatives (i.e., information enabling the prediction of how the system would respond).
6. Assess exposure to chemicals (i.e., support the risk assessment).

<sup>4</sup>Initial screening of candidate Terrestrial Biological Study Areas.

<sup>5</sup>Phase I of Geochronological Dating only.

Table 5-2

Allied Paper, Inc./Portage Creek/Kalamazoo River  
 Superfund Site

RI/FS Work Plan

RI Samples - Georgia-Pacific Corporation Kalamazoo Mill Investigation

Location	Sample ID	Media	Number of Samples	Depth Intervals <sup>1</sup>	Parameter(s) <sup>2</sup>	RI Data Collection Obj. <sup>3</sup>
Stormwater Solids	GPD-1	solids	1	• 0 - 6"	PCBs, PCDDs, PCDFs	1,2,3,4
Former Primary Clarifier	GPC-1	solids	1	• 0 - 6"	PCBs	1,2,4
Three Former Lagoons (NW of Mill)	GPL-1 to GPL-3	soil/ residuals	6	• 0 - 6"; • Native soil 0.5' to 2.5' below base of residuals <sup>4</sup>	PCBs	1,2,4
Two Former Lagoons (near primary clarifier)	GPL-4 and GPL-5	soil/ residuals	6	• 0-6"; • Native soil 0.5' to 2.5' below base of residual <sup>4</sup>	PCBs	1,2,4
	GPL-6 and GPL-7	soil/ residuals	0	• to 2.5' below base of residuals <sup>4</sup>	None (visual only)	2

(See Notes on Page 2)

Table 5-2  
(cont'd)

Allied Paper, Inc./Portage Creek/Kalamazoo River  
Superfund Site

RI/FS Work Plan

RI Samples - Georgia-Pacific Corporation Kalamazoo Mill Investigation

Notes:

<sup>1</sup>Soil samples will be composited for each depth interval sampled.

<sup>2</sup>Abbreviations used in this table:

PCBs	= Polychlorinated biphenyls
PCDDs	= Polychlorinated dibenzo-p-dioxins
PCDFs	= Polychlorinated dibenzofurans

<sup>3</sup>RI Data Collection Objectives:

1. Characterize chemical nature of wastes at the site.
2. Determine the spatial distribution of chemicals.
3. Identify chemical migration pathways and movement.
4. Identify sources.

<sup>4</sup>If an identifiable interface is observed between the base to the residuals and native soil, the native soil sample interval may be modified to allow collection of a representative sample of the native soil below the interface. The specific location will be identified in the field.

Table 5-3

Allied Paper, Inc./Portage Creek/Kalamazoo River  
Superfund Site

RI/FS Work Plan

RI Samples - Simpson Plainwell Paper Company Mill Investigation

Location	Sample ID	Media	Number of Samples	Depth Intervals <sup>1</sup>	Parameter(s) <sup>2</sup>	RI Data Collection Obj. <sup>3</sup>
Stormwater Solids	SPD-1	solids	1	• 0-6"	PCBs, PCDDs, PCDFs	1,2,3,4
Former Primary Clarifier	SPC-1	solids	1	• 0-6"	PCBs	1,2,4
Open Drain	SPC-2	solids	1	• 0-6"	PCBs	1,2,4
Former Secondary Clarifier	SPC-3	solids	1	• 0-6"	PCBs	1,2,4
Former Lagoons	SPL-1 to SPL-5	soil/ residuals	15	• 0-6" • 0.5' to 1.5' above base of residuals if residual < 5' deep • 0.5' to 2.5' below base of residuals <sup>4</sup>	PCBs	1,2,4
Former Aeration Basin	SPL-6	soil/ residuals	2	• 0-6" • Native soil 0.5' to 2.5' below base of residuals <sup>4</sup>	PCBs	1,2,4
Former Lagoons	SPL-7 to SPL-13	soil/ residuals	0	• to 2.5' below base of residuals <sup>4</sup>	None (visual only)	2

(See Notes on Page 2)

Table 5-3  
(cont'd)

Allied Paper, Inc./Portage Creek/Kalamazoo River  
Superfund Site

RI/FS Work Plan

RI Samples - Simpson Plainwell Paper Company Mill Investigation

Notes:

<sup>1</sup>Soil samples will be composited for each depth interval sampled.

<sup>2</sup>Abbreviations used in this table:

PCBs	= Polychlorinated biphenyls
PCDDs	= Polychlorinated dibenzo-p-dioxins
PCDFs	= Polychlorinated dibenzofurans

<sup>3</sup>RI Data Collection Objectives:

1. Characterize chemical nature of wastes at the site.
2. Determine the spatial distribution of chemicals.
3. Identify chemical migration pathways and movement.
4. Identify sources.

<sup>4</sup>If an identifiable interface is observed between the base to the residuals and native soil, the native soil sample interval may be modified to allow collection of a representative sample of the native soil below the interface. The specific location will be identified in the field.

Table 5-4  
Allied Paper, Inc./Portage Creek/Kalamazoo River  
Superfund Site  
RI/FS Work Plan  
RI Samples - Portage Paper Mill Investigation

Location	Sample ID	Media	Number of Samples	Depth Intervals <sup>1</sup>	Parameter(s) <sup>2</sup>	RI Data Collection Obj. <sup>3</sup>
Stormwater Outfall	PPC-1	solids	1	0-6"	PCBs, PCDDs, PCDFs	1,2,3,4
Mill A Pipe <sup>4</sup>	PPC-2	solids	1	0-6"	PCBs	1,2,3,4
Pump Station Mill D	PPC-3	solids	1	0-6"	PCBs	1,2,4
Sump	PPC-4	solids	1	0-6"	PCBs	1,2,3,4
Grey Tank	PPC-5	solids	1	0-6"	PCBs	1,2,3,4
Primary Clarifier	PPC-6	solids	1	0-6"	PCBs	1,2,3,4

Notes:

<sup>1</sup>Soil samples will be composited for each depth interval sampled.

<sup>2</sup>Abbreviations used in this table:

- PCBs = Polychlorinated biphenyls
- PCDDs = Polychlorinated dibenzo-p-dioxins
- PCDFs = Polychlorinated dibenzofurans

Table 5-4  
(cont'd)

Allied Paper, Inc./Portage Creek/Kalamazoo River  
Superfund Site

RI/FS Work Plan

RI Samples - Portage Paper Mill Investigation

Notes: (Cont'd)

<sup>3</sup>RI Data Collection Objectives:

1. Characterize chemical nature of wastes at the site.
2. Determine the spatial distribution of chemicals.
3. Identify chemical migration pathways and movement.
4. Identify sources.

<sup>4</sup>Mill A pipe may not be locatable.

Table 5-5

Allied Paper, Inc./Portage Creek/Kalamazoo River  
Superfund Site

RI/FS Work Plan

RI Samples - Former King Mill Investigation

Location	Sample ID	Media	Number of Samples	Depth Intervals <sup>1</sup>	Parameter(s) <sup>2</sup>	RI Data Collection Obj. <sup>3</sup>
Drainage	KMD-1	soil	1	• 0-6"	PCBs	1,2,3,4
Storm Sewer (48")	KMS-1	sediment	1	• 0-6"	PCBs	1,2,3,4
Former Clarifiers	KM-1 and KM-2	sediment	4	• 0-6" • 2-4'	PCBs	1,2,4
Former N-S Lagoon	KM-3 and KM-5	soil/residuals	0	• to 2.5' below base of residuals <sup>4</sup>	None (visual only)	2
Former N-S Lagoon	KM-4	soil/residuals	3	• 0-6" • 0.5' to 1.5' above base of residuals • 0.5' to 2.5' below base of residuals <sup>4</sup>	PCBs	1,2,4
Former NE Lagoon	KM-6 and KM-8	soil/residuals	0	• to 2.5' below base of residuals <sup>4</sup>	None (visual only)	2
Former NE Lagoon	KM-7	soil/residuals	3	• 0-6" • 0.5' to 1.5' above base of residuals • 0.5' to 2.5' below base of residuals <sup>4</sup>	PCBs	1,2,4

(See Notes on Page 2)

Table 5-5  
(cont'd)

Allied Paper, Inc./Portage Creek/Kalamazoo River  
Superfund Site

RI/FS Work Plan

RI Samples - Former King Mill Investigation

Notes:

<sup>1</sup>Soil samples will be homogenized for each depth interval sampled.

<sup>2</sup>Abbreviations used in this table:

PCBs = Polychlorinated biphenyls

<sup>3</sup>RI Data Collection Objectives:

1. Characterize chemical nature of wastes at the site.
2. Determine the spatial distribution of chemicals.
3. Identify chemical migration pathways and movement.
4. Identify sources.

<sup>4</sup>If an identifiable interface is observed between the base to the residuals and native soil, the native soil sample interval may be modified to allow collection of a representative sample of the native soil below the interface. The specific location will be identified in the field.

Table 5-6

Allied Paper, Inc./Portage Creek/Kalamazoo River  
Superfund Site

RI/FS Work Plan

RI Samples - Former Monarch Mill Investigation

Location	Sample ID	Media	Number of Samples	Depth Intervals <sup>1</sup>	Parameter(s) <sup>2</sup>	RI Data Collection Obj. <sup>3</sup>
Former Mill Race Discharge	MM-1	sediment	1	See Note <sup>1</sup>	PCBs	1,2,3,4
Former Mill Race Discharge	MM-2	sediment	1	See Note <sup>1</sup>	PCBs	1,2,3,4

Notes:

<sup>1</sup>Soil samples will be homogenized for each depth interval sampled. Actual depth will be determined in the field to a maximum of 15 feet. If auger refusal is encountered (i.e., due to buried pipe), boreholes will be abandoned and no samples will be collected.

<sup>2</sup>Abbreviations used in this table:

PCBs = Polychlorinated biphenyls

<sup>3</sup>RI Data Collection Objectives:

1. Characterize chemical nature of mill race sediments at the site.
2. Determine the spatial distribution of chemicals.
3. Identify chemical migration pathways and movement.
4. Identify sources.

Table 5-7

Allied Paper, Inc./Portage Creek/Kalamazoo River  
Superfund Site

RI/FS Work Plan

RI Samples - King Street Storm Sewer Investigation

Location	Sample ID	Media	Number of Samples	Depth Intervals <sup>1</sup>	Parameter(s) <sup>2</sup>	RI Data Collection Obj. <sup>3</sup>
Western Side	KSHB-1 to KSHB-4	soil	8	<ul style="list-style-type: none"> <li>• 0-6"</li> <li>• 1.5' - 2.5'</li> </ul>	PCBs	1,2,3,4
Culvert	KSHB-5	sediment	2	<ul style="list-style-type: none"> <li>• 0-6"</li> <li>• 1.5' - 2.5'</li> </ul>	PCBs, CLP TCL/TAL (lower only)	1,2,3,4
Eastern Side	KSHB-6 and KSHB-7	soil	4	<ul style="list-style-type: none"> <li>• 0-6"</li> <li>• 1.5' - 2.5'</li> </ul>	PCBs	1,2,3,4
Western Side	KSHB-8 to KSHB-11	soil	0	<ul style="list-style-type: none"> <li>• 0-3'</li> </ul>	none (visual only)	2

**Notes:**

<sup>1</sup>Soil samples will be homogenized for each depth interval sampled.

<sup>2</sup>Abbreviations used in this table:

PCBs = Polychlorinated biphenyls

CLP TCL/TAL = Contract Laboratory Program Target Compound List/Target Analyte List

<sup>3</sup>RI Data Collection Objectives:

1. Characterize chemical nature of wastes at the site.
2. Determine the spatial distribution of chemicals.
3. Identify chemical migration pathways and movement.
4. Identify sources.

Table 5-8  
Allied Paper, Inc./Portage Creek/Kalamazoo River  
Superfund Site

RI/FS Work Plan

RI Samples - Surface Water Investigation

Study Activity	Sample Media	Sampling Location	Type of Analysis <sup>1</sup>	No. of Samples	RI Data Collection Objectives <sup>2</sup>
Event-Specific Sampling	surface water	Portage Creek-Michigan Avenue	<ul style="list-style-type: none"><li>• PCBs</li><li>• TSS</li><li>• field parameters<sup>3</sup></li></ul>	24	1,3,4,6
			<ul style="list-style-type: none"><li>• CLP TCL/TAL</li></ul>	1	
		Kalamazoo River-River Street	<ul style="list-style-type: none"><li>• PCBs</li><li>• TSS</li><li>• field parameters</li></ul>	24	
			<ul style="list-style-type: none"><li>• CLP TCL/TAL</li></ul>	1	
		Kalamazoo River-Michigan Avenue	<ul style="list-style-type: none"><li>• PCBs</li><li>• TSS</li><li>• field parameters</li></ul>	24	
			<ul style="list-style-type: none"><li>• CLP TCL/TAL</li></ul>	1	
		Kalamazoo River - Farmer Street downstream of Otsego City Dam	<ul style="list-style-type: none"><li>• PCBs</li><li>• TSS</li><li>• field parameters</li></ul>	24	
			<ul style="list-style-type: none"><li>• CLP TCL/TAL</li></ul>	1	

TABLE 5-8  
(Cont'd)  
Allied Paper, Inc./Portage Creek/Kalamazoo River  
Superfund Site

RI/FS Work Plan

Remedial Investigation Samples - Surface Water Investigation

Study Activity	Sample Media	Sampling Location	Type of Analysis <sup>1</sup>	No. of Samples	RI Data Collection Objectives <sup>2</sup>
Event-Specific Sampling (cont'd.)	surface water (cont'd.)	Kalamazoo River-Highway M-118	<ul style="list-style-type: none"><li>• PCBs</li><li>• TSS</li><li>• field parameters</li></ul>	24	1,3,4,6
			<ul style="list-style-type: none"><li>• CLP TCL/TAL</li></ul>	1	
		Kalamazoo River- Highway 89 below Lake Allegan Dam	<ul style="list-style-type: none"><li>• PCBs</li><li>• TSS</li><li>• field parameters</li></ul>	6	
			<ul style="list-style-type: none"><li>• CLP TCL/TAL</li></ul>	1	
Base-Flow Sampling	surface water	Portage Creek-Michigan Avenue	<ul style="list-style-type: none"><li>• PCBs</li><li>• TSS</li><li>• field parameters</li></ul>	8-10	1,2,3,4,5,6
			<ul style="list-style-type: none"><li>• CLP TCL/TAL</li></ul>	1	
		Kalamazoo River-River Street	<ul style="list-style-type: none"><li>• PCBs</li><li>• TSS</li><li>• field parameters</li></ul>	8-10	
			<ul style="list-style-type: none"><li>• CLP TCL/TAL</li></ul>	1	

TABLE 5-8  
(Cont'd)  
Allied Paper, Inc./Portage Creek/Kalamazoo River  
Superfund Site

RI/FS Work Plan

Remedial Investigation Samples - Surface Water Investigation

Study Activity	Sample Media	Sampling Location	Type of Analysis <sup>1</sup>	No. of Samples	RI Data Collection Objectives <sup>2</sup>
Base-Flow Sampling (cont'd)	surface water (cont'd)	Kalamazoo River-Michigan Avenue	<ul style="list-style-type: none"><li>• PCBs</li><li>• TSS</li><li>• field parameters</li></ul>	8-10	1,2,3,4,5,6
			<ul style="list-style-type: none"><li>• CLP TCL/TAL</li></ul>	1	
		Kalamazoo River-D Avenue	<ul style="list-style-type: none"><li>• PCBs</li><li>• TSS</li><li>• field parameters</li></ul>	8-10	
			<ul style="list-style-type: none"><li>• CLP TCL/TAL</li></ul>	1	
		Kalamazoo River-Farmer Street downstream of Otsego City Dam	<ul style="list-style-type: none"><li>• PCBs</li><li>• TSS</li><li>• field parameters</li></ul>	8-10	
			<ul style="list-style-type: none"><li>• CLP TCL/TAL</li></ul>	1	
		Kalamazoo River-Highway M-118	<ul style="list-style-type: none"><li>• PCBs</li><li>• TSS</li><li>• field parameters</li></ul>	8-10	
			<ul style="list-style-type: none"><li>• CLP TCL/TAL</li></ul>	1	

TABLE 5-8  
(Cont'd)  
Allied Paper, Inc./Portage Creek/Kalamazoo River  
Superfund Site

RIFS Work Plan

Remedial Investigation Samples - Surface Water Investigation

Study Activity	Sample Media	Sampling Location	Type of Analysis <sup>1</sup>	No. of Samples	RI Data Collection Objectives <sup>2</sup>
Base-Flow Sampling (cont'd)	surface water (cont'd)	Kalamazoo River-Highway 89 below Lake Allegan Dam	• PCBs • TSS • field parameters	8-10	1,2,3,4,5,6
			• CLP TCL/TAL	1	

Notes:  
<sup>1</sup>Abbreviations used in this table:  
PCBs = Polychlorinated biphenyls  
CLP TCL/TAL = Contract Laboratory Program Target Compound List/Target Analyte List  
TSS = Total Suspended Solids

<sup>2</sup>RI Data Collection Objectives:  
1. Characterize chemical nature of wastes at the site.  
2. Determine the spatial distribution of chemicals.  
3. Identify chemical migration pathways and movement.  
4. Identify sources.  
5. Support the evaluation of remedial alternatives.  
    a. Assess the technical feasibility of an alternative (e.g., material characteristics).  
    b. Assess the effectiveness of potential alternatives (i.e., information enabling the prediction of how the system would respond).  
6. Assess exposure to chemicals (i.e., support the risk assessment).

<sup>3</sup>Field Parameters include:  
flow, temperature, pH, dissolved oxygen, conductivity, turbidity.

Table 5-9

Allied Paper, Inc./Portage Creek/Kalamazoo River  
Superfund Site

RI/FS Work Plan

List of Potential Remedial Technologies

Potentially Applicable Remedial Technology	Process Description	Potentially Applicable Media <sup>1</sup>	Potentially Applicable Constituents <sup>2</sup>
1.0 In-Situ Containment/Control			
1.1 Capping	Isolation and containment of constituents by placement of layer(s) of physical materials (e.g., granular materials, clay, concrete, asphalt, synthetic materials, grout or cement-filled geotextile mats, bentonite/synthetic membrane pads) over areas containing constituents.	Sediments, soils, residuals	Organics, Inorganics
1.2 Erosion Control	Prevention of erosion (and subsequent transport) of contaminated materials by velocity control or barrier mechanisms, or by reimpoundment of exposed areas containing constituents.	Sediments, surface water, soils	Organics, Inorganics
1.3 Hydraulic Containment	Use of physical barriers (e.g., slurry walls, sheet piles, injected screens, grout curtains) to prevent the movement of contaminated groundwater.	Groundwater	Organics, Inorganics
2.0 In-Situ Treatment			
2.1 Immobilization	Immobilization of constituents of concern in a solid mass (monolith), formed either by injecting and mixing or immobilization agent into the media or by melting the media.	Sediments, soils, residuals	Organics, Inorganics
2.2 Extraction	Removal of constituents of concern from media by extraction wells, steam, or vacuum, followed by treatment of constituents.	Sediments, soils, residuals	Organics (based on technology process), Inorganics
2.3 Biodegradation	Degradation of media constituents utilizing microorganisms in either an aerobic or anaerobic environment.	Sediments, soils, residuals, water	Various organics (based on technology process)
2.4 Chemical	Use of chemical agents to change the nature of the constituents through oxidation, reduction, or neutralization.	Sediments, soils, residuals, water	Various organics and Inorganics (based on technology process)
2.5 Thermal	Heating of media with radio frequency waves to vaporize and thermally destroy constituents.	Sediments, soils, residuals	Organics
3.0 In-situ Support Technologies			
	Technologies which enhance the effectiveness of in-situ treatment technologies including groundwater zone dewatering to enhance fluid or vapor-flow.	Sediments, soils, residuals	Organics, Inorganics
4.0 Removal			

(See Notes on Page 3)  
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Table 5-9  
(Cont'd)

Allied Paper, Inc./Portage Creek/Kalamazoo River  
Superfund Site

RI/FS Work Plan

List of Potential Remedial Technologies

Potentially Applicable Remedial Technology	Process Description	Potentially Applicable Media <sup>1</sup>	Potentially Applicable Constituents <sup>2</sup>
4.1 Dredging	Removal and transportation of bottom sediments.	Sediments, residuals	Organics, Inorganics
4.2 Excavation	Physical removal of waste constituents by typical excavation equipment under "dry" conditions.	Sediments, soils, residuals	Organics, Inorganics
4.3 Groundwater Removal	Collection of contaminated groundwater for treatment by wells or drains.	Groundwater	Organics, Inorganics
5.0 Disposal			
5.1 Off-site	Disposal of media in an existing permitted TSCA/RCRA, or solid waste landfill facility.	Sediments, soils, residuals	Organics, Inorganics
5.2 On-site	Disposal of media in a Confined Disposal Facility (upland or in-water) or newly-constructed permitted TSCA/RCRA or solid waste landfill facility.	Sediments, soils, residuals	Organics, Inorganics
5.3 Groundwater	Disposal of treated or untreated water through discharge to surface water, discharge to POTW, or reinjection underground.	Water	Organics, Inorganics
6.0 Upland Treatment			
6.1 Immobilization	Immobilization of constituents of concern by mixing of excavated/removed material with immobilization agents to form a monolith which is subsequently disposed.	Sediments, soils, residuals	Organics, Inorganics
6.2 Extraction	Removal of constituents of concern from media for subsequent management via chemical solvents, water/surfactants, thermal processes, or steam.	Sediments, soils, residuals, water	Various organics and inorganics (based on technology process)
6.3 Biodegradation	Degradation of constituents of concern under aerobic or anaerobic environments.	Sediments, soils, residuals, water (< 1% suspended solids)	Organics
6.4 Chemical Treatment	Use of chemical agents to change the nature of the constituents through oxidation, reduction, neutralization, hydrolysis, dehalogenation/dechlorination, chlorinolysis, ion exchange, or photolysis.	Sediments, soils, residuals, water	Various organics and inorganics (based on technology process)
6.5 Thermal Destruction	Destruction/decomposition of wastes through the application of heat and high temperatures in an oxygen or oxygen-free atmosphere.	Sediments, soils, residuals, water	Various organics (based on technology process)

(See Notes on Page 3)  
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Table 5-9  
(Cont'd)

Allied Paper, Inc./Portage Creek/Kalamazoo River  
Superfund Site

RI/FS Work Plan

List of Potential Remedial Technologies

Potentially Applicable Remedial Technology	Process Description	Potentially Applicable Media <sup>1</sup>	Potentially Applicable Constituents <sup>2</sup>
6.6 Physical Separation	Separation from media or concentration of constituents of concern through physical processes.	Sediments, soils, residuals, water	Various organics and inorganic (based on technology process)
7.0 Support Technologies			
7.1 Dewatering	Processes which increase the solids content of liquid slurries.	Sediments, soils, residuals, water	Organics, Inorganics
7.2 Debris	Washing of debris with water and detergent solutions to remove and collect constituents of concern in the wash solution for subsequent treatment, leaving washed debris for subsequent management.	Debris	Not applicable

Notes:

- <sup>1</sup> Media which could be handled by the corresponding technology process. These media are not necessarily all inclusive of each vendor process.
- <sup>2</sup> Constituents which could be managed by the corresponding technology process. These constituents are not necessarily all inclusive of each vendor process.

POTW - Publicly-owned Treatment Works  
RCRA - Resource Conservation & Recovery Act  
TSCA - Toxic Substances Control Act

Table 5-10  
Allied Paper, Inc./Portage Creek/Kalamazoo River  
Superfund Site  
RI/FS Work Plan  
Data Requirements for Technology Evaluation

Potentially Applicable Remedial Technology	Data Required for FS Evaluation of Remedial Technology	Proposed RI Data Collection
1.0 In-Situ Containment/Control 1.1 Capping	<ul style="list-style-type: none"><li>- accessibility to area</li><li>- chemical characterization of material</li><li>- spatial extent of material containing constituents</li><li>- surface topography</li><li>- bearing capacity of in-situ material</li><li>- estimates of partitioning coefficients</li><li>- hydrodynamic (e.g., water depths, water velocity) data</li><li>- historic river stage data</li></ul>	<ul style="list-style-type: none"><li>- soil/sediment sampling and analyses for CLP TCL/TAL constituents, PCBs, and TOC</li><li>- review available topographic data or confirm with RI survey data</li><li>- particle size data</li><li>- consolidation tests</li><li>- hydrodynamic field data</li><li>- USGS records for river stage data</li></ul>
1.2 Erosion Control	<ul style="list-style-type: none"><li>- physical characterization of river system</li><li>- particle size analyses</li><li>- spatial extent of material containing constituents</li><li>- density and geologic characteristics of erodible material</li><li>- surface topography of target areas</li><li>- estimates of partitioning coefficients</li><li>- location of wetlands</li><li>- hydrodynamic (e.g., water depths, water velocity) data</li><li>- historic river stage data</li></ul>	<ul style="list-style-type: none"><li>- site reconnaissance</li><li>- flow rate measurements</li><li>- particle size data</li><li>- lithology description</li><li>- select soil/sediment sampling analyses for CLP TCL/TAL constituents, PCBs, and TOC</li><li>- review of topographic and wetland data</li><li>- hydrodynamic field data</li><li>- USGS records for river stage data</li></ul>

Table 5-10  
(Cont'd)  
Allied Paper, Inc./Portage Creek/Kalamazoo River  
Superfund Site

RI/FS Work Plan

Data Requirements for Technology Evaluation

Potentially Applicable Remedial Technology	Data Required for FS Evaluation of Remedial Technology	Proposed RI Data Collection
1.3 Hydraulic Containment	<ul style="list-style-type: none"><li>- chemical characterization of material</li><li>- hydrogeologic characteristics of target area (including permeabilities and hydraulic gradients)</li><li>- particle size analyses</li><li>- moisture content, density</li><li>- spatial extent of material containing constituents</li></ul>	<ul style="list-style-type: none"><li>- site reconnaissance</li><li>- particle size data</li><li>- moisture content</li><li>- lithology description</li><li>- select sampling analyses for CLP TCL/TAL constituents, PCBs, and partitioning coefficients</li><li>- review of topographic and wetland data</li><li>- record groundwater elevations</li><li>- groundwater sampling</li><li>- hydraulic conductivity</li></ul>
2.0 In-Situ Treatment 2.1 Immobilization	<ul style="list-style-type: none"><li>- chemical characterization of material</li><li>- spatial extent of material containing constituents</li><li>- particle size analyses</li><li>- moisture content, density</li><li>- accessibility</li><li>- dept to the water table</li><li>- organic content</li><li>- pH, alkalinity</li><li>- combustible material content</li><li>- presence of monovalent alkali earth (Na, Li, K) and metal oxides (Pa, Si, Al)</li><li>- hydraulic conductivity</li></ul>	<ul style="list-style-type: none"><li>- soil/sediment sampling and analyses for CLP TCL/TAL constituents, PCBs, and TOC</li><li>- lithology description</li><li>- particle size data</li><li>- moisture content</li><li>- density</li></ul>

Table 5-10  
(Cont'd)  
Allied Paper, Inc./Portage Creek/Kalamazoo River  
Superfund Site

R/FS Work Plan

Data Requirements for Technology Evaluation

Potentially Applicable Remedial Technology	Data Required for FS Evaluation of Remedial Technology	Proposed RI Data Collection
2.2 Extraction	<ul style="list-style-type: none"><li>- solubility and vapor pressure of constituents</li><li>- volume estimates of material containing constituents</li><li>- particle size analyses</li><li>- TOC, moisture content, density, permeability</li><li>- chemical characterization of material</li><li>- partition coefficients</li><li>- hydrogeological characteristics of area</li></ul>	<ul style="list-style-type: none"><li>- soil/sediment sampling and analyses for CLP TCL/TAL constituents, PCBs, and TOC</li><li>- lithology description</li><li>- particle size data</li><li>- moisture content</li></ul>
2.3 Biodegradation	<ul style="list-style-type: none"><li>- volume estimates of material containing constituents</li><li>- chemical characterization of material</li><li>- moisture content, density, pH, temperature</li><li>- TOC, redox potential, C:N:P ratio, permeability, oxygen content</li><li>- presence of microorganisms/endogenous activity</li><li>- solubility of constituents</li></ul>	<ul style="list-style-type: none"><li>- soil/sediment sampling and analyses for CLP TCL/TAL constituents, PCBs, and TOC</li><li>- moisture content</li><li>- density</li><li>- select analyses to determine chemical nature of sediment</li><li>- high resolution chromatographic data for PCBs</li></ul>
2.4 Chemical	<ul style="list-style-type: none"><li>- volume estimates of material containing constituents</li><li>- particle size analyses</li><li>- moisture content</li><li>- chemical characterization of material</li><li>- hydrogeologic conditions</li><li>- pH</li></ul>	<ul style="list-style-type: none"><li>- soil/sediment sampling and analyses for CLP TCL/TAL constituents and PCBs</li><li>- lithology description</li><li>- particle size data</li><li>- moisture content</li><li>- density</li></ul>

Table 5-10  
(Cont'd)  
Allied Paper, Inc./Portage Creek/Kalamazoo River  
Superfund Site

R/FS Work Plan

Data Requirements for Technology Evaluation

Potentially Applicable Remedial Technology	Data Required for FS Evaluation of Remedial Technology	Proposed RI Data Collection
2.5 Thermal	<ul style="list-style-type: none"><li>- volume estimates of material containing constituents</li><li>- particle size analyses</li><li>- BTU content</li><li>- moisture content, ash content, pH, and flash point</li><li>- chemical characterization of material</li><li>- levels of RCRA metals, chlorine, sulfur, nitrogen, phosphorus, fluorine, VOCs, and SVOCs</li></ul>	<ul style="list-style-type: none"><li>- soil/sediment sampling and analyses for CLP TCL/TAL constituents, and PCBs</li><li>- lithology description</li><li>- particle size data</li><li>- moisture content</li><li>- density</li></ul>
3.0 In-Situ Support Technologies	<ul style="list-style-type: none"><li>- spatial extent of material containing constituents</li><li>- surface topography</li><li>- hydrogeologic characteristics</li><li>- moisture content and density</li><li>- groundwater elevations</li><li>- in-situ permeability/conductivity</li></ul>	<ul style="list-style-type: none"><li>- soil/sediment sampling and analyses for CLP TCL/TAL constituents</li><li>- lithology description</li><li>- moisture content and density</li><li>- review of regional geologic information</li><li>- record groundwater elevations</li></ul>

Table 5-10  
(Cont'd)  
Allied Paper, Inc./Portage Creek/Kalamazoo River  
Superfund Site

R/FS Work Plan

Data Requirements for Technology Evaluation

Potentially Applicable Remedial Technology	Data Required for FS Evaluation of Remedial Technology	Proposed RI Data Collection
6.0 Soil/Sediment/Residuals Treatment 6.1 Immobilization	<ul style="list-style-type: none"><li>- chemical characterization of material</li><li>- spatial extent of contaminated material</li><li>- particle size ranges</li><li>- moisture content and density</li><li>- accessibility</li><li>- organic content</li><li>- pH, alkalinity</li></ul>	<ul style="list-style-type: none"><li>- soil/sediment sampling and analyses for CLP TCL/TAL constituents, PCBs, and TOC</li><li>- lithology description</li><li>- particle size range data</li><li>- moisture content</li><li>- density</li><li>- review available topographic data and confirm with RI survey data</li></ul>
6.2 Extraction	<ul style="list-style-type: none"><li>- volume estimates of material containing constituents</li><li>- particle size analyses</li><li>- moisture content, density, TOC, pH</li><li>- chemical characterization of material</li><li>- partition coefficient</li><li>- BTU content</li><li>- presence of metals</li><li>- presence of aluminum</li></ul>	<ul style="list-style-type: none"><li>- soil/sediment sampling and analyses for CLP TCL/TAL constituents, PCBs, and TOC</li><li>- lithology description</li><li>- particle size data</li><li>- moisture content</li><li>- density</li></ul>

Table 5-10  
(Cont'd)  
Allied Paper, Inc./Portage Creek/Kalamazoo River  
Superfund Site

R/VFS Work Plan

Data Requirements for Technology Evaluation

Potentially Applicable Remedial Technology	Data Required for FS Evaluation of Remedial Technology	Proposed RI Data Collection
6.3 Biodegradation	<ul style="list-style-type: none"><li>- volume estimates of material containing constituents</li><li>- chemical characterization of material</li><li>- moisture content, density, pH, temperature</li><li>- TOC, redox potential, C:N:P ratio, permeability, and oxygen content</li><li>- particle size analyses</li><li>- solubility of constituents</li><li>- presence of microorganisms/endogenous activity</li></ul>	<ul style="list-style-type: none"><li>- soil/sediment analyses for CLP TCL/TAL constituents, PCBs, and TOC</li><li>- moisture content</li><li>- density</li><li>- select analyses to determine nature of sediment</li></ul>
6.4 Chemical Destruction	<ul style="list-style-type: none"><li>- volume estimates of material containing constituents</li><li>- particle size analyses</li><li>- moisture content, density, pH, TOC</li><li>- chemical characterization of material</li><li>- presence of aluminum</li></ul>	<ul style="list-style-type: none"><li>- soil/sediment sampling and analyses for CLP TCL/TAL constituents and PCBs</li><li>- lithology description</li><li>- particle size data</li><li>- moisture content</li><li>- density</li><li>- pH</li><li>- TOC</li></ul>

Table 5-10  
(Cont'd)  
Allied Paper, Inc./Portage Creek/Kalamazoo River  
Superfund Site

RI/FS Work Plan

Data Requirements for Technology Evaluation

Potentially Applicable Remedial Technology	Data Required for FS Evaluation of Remedial Technology	Proposed RI Data Collection
6.5 Thermal Destruction	<ul style="list-style-type: none"> <li>- volume estimates of material containing constituents</li> <li>- particle size analyses</li> <li>- BTU content, moisture content, ash content, ash fusion temperature, pH, flash point, and density</li> <li>- chemical characterization of material</li> <li>- presence of RCRA metals, chlorine, sulfur, nitrogen, phosphorus, fluorine, bromide, sodium, potassium, VOCs, and SVOCs</li> <li>- suspended solids content (if water)</li> <li>- viscosity</li> <li>- COD and pH</li> </ul>	<ul style="list-style-type: none"> <li>- lithology description</li> <li>- particle size data</li> <li>- moisture content</li> <li>- density</li> <li>- sampling and analyses for CLP TCL/TAL constituents, and PCBS</li> <li>- general water quality parameters (e.g., TSS, COD, pH, oil and grease content, etc.)</li> </ul>
6.6 Physical	<ul style="list-style-type: none"> <li>- volume estimates of material containing constituents</li> <li>- chemical characterization of material</li> <li>- suspended solids content, oil and grease content</li> <li>- pH and specific gravity</li> </ul>	<ul style="list-style-type: none"> <li>- water sampling and analyses for CLP TCL/TAL constituents, general water quality parameters and TOC</li> <li>- TSS analyses</li> </ul>

Table 5-10  
(Cont'd)  
Allied Paper, Inc./Portage Creek/Kalamazoo River  
Superfund Site

R/VFS Work Plan

Data Requirements for Technology Evaluation

Potentially Applicable Remedial Technology	Data Required for FS Evaluation of Remedial Technology	Proposed RI Data Collection
7.0 Support Technologies	<ul style="list-style-type: none"><li>- volume estimates of material containing constituents</li><li>- particle size analyses</li><li>- moisture content and density</li><li>- settleability of material</li><li>- pH, oil, and grease</li></ul>	<ul style="list-style-type: none"><li>- soil/sediment sampling and analyses for CLP TCL/TAL constituents and PCBs</li><li>- lithology characterization</li><li>- particle size data</li><li>- moisture content</li><li>- density</li><li>- settleability</li><li>- hydrogeological characterization</li></ul>

Notes:

( ) indicates that data requirement or data collection pertains to the technology process within the brackets only.

CLP TCL/TAL - Contract Laboratory Program Target Compound List/Target Analyte List

TOC - Total Organic Carbon

TSS - Total Suspended Solids

PCBs - Polychlorinated Biphenyls

VOCs - Volatile Organic Compounds

COD - Carbon Oxygen Demand

SVOCs - Semivolatile Organic Compounds

C:N:P ratio - Carbon to nitrogen to phosphorus ratio

RCRA - Resource Conservation and Recovery Act

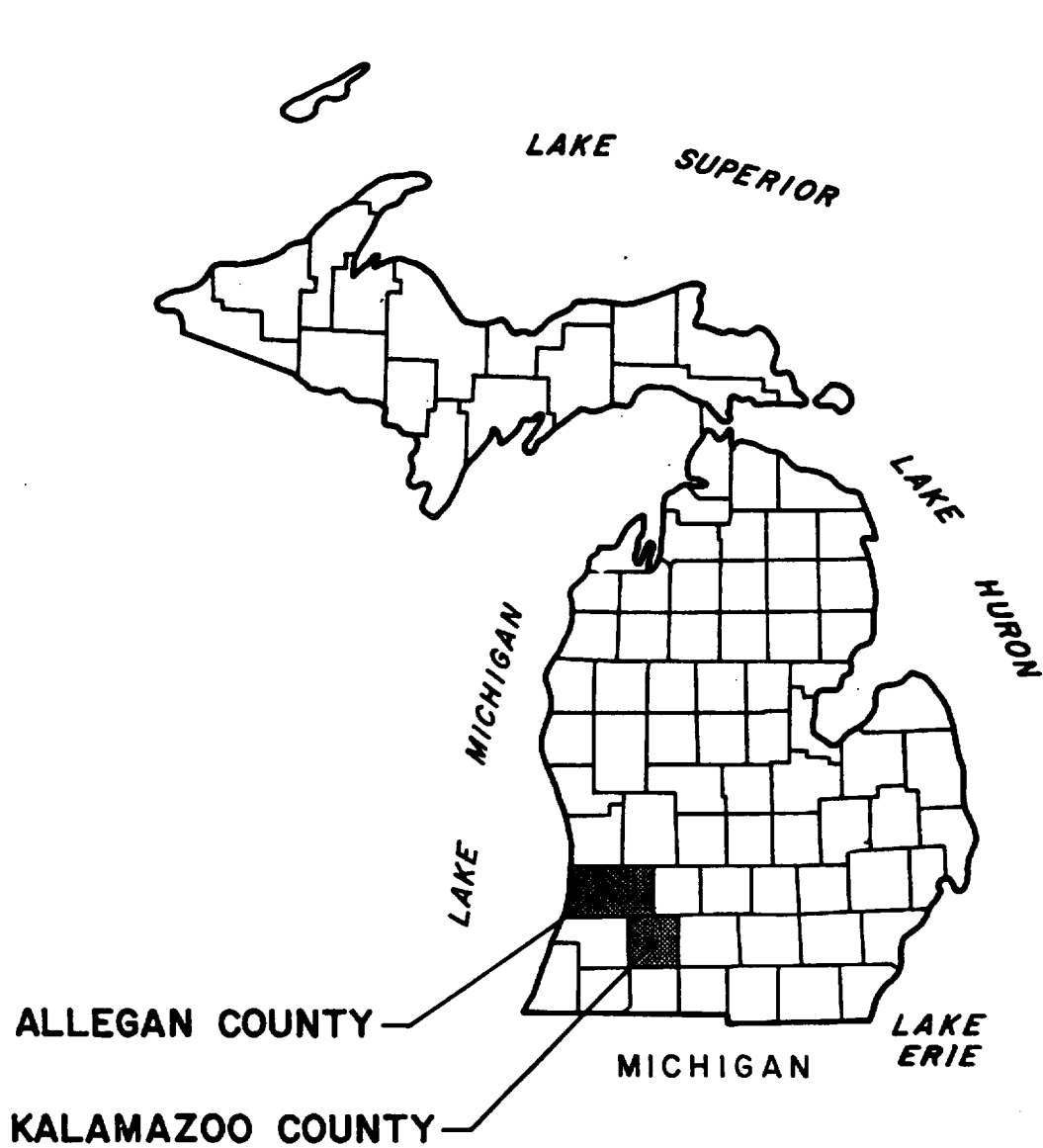
TSCA - Toxic Substances Control Act

POTW - Publicly Owned Treatment Works

UV - Ultraviolet



## Figures



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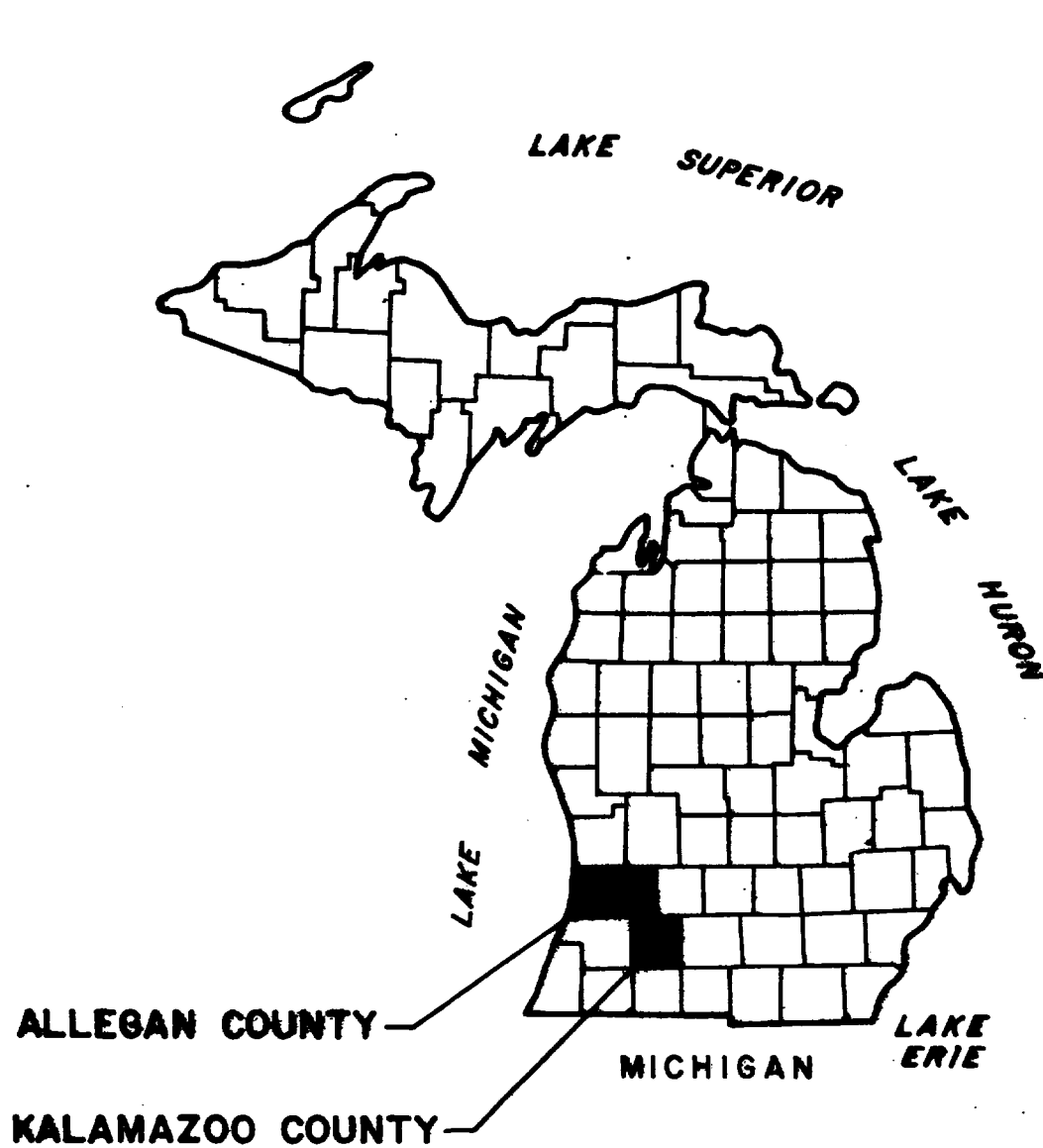
KALAMAZOO RIVER STUDY GROUP  
ALLIED PAPER, INC./PORTAGE CREEK/  
KALAMAZOO RIVER SUPERFUND SITE

RI/FS WORK PLAN

LOCATION PLAN

FIGURE

1



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KALAMAZOO RIVER SUPERFUND SITE

RI/F5 WORK PLAN

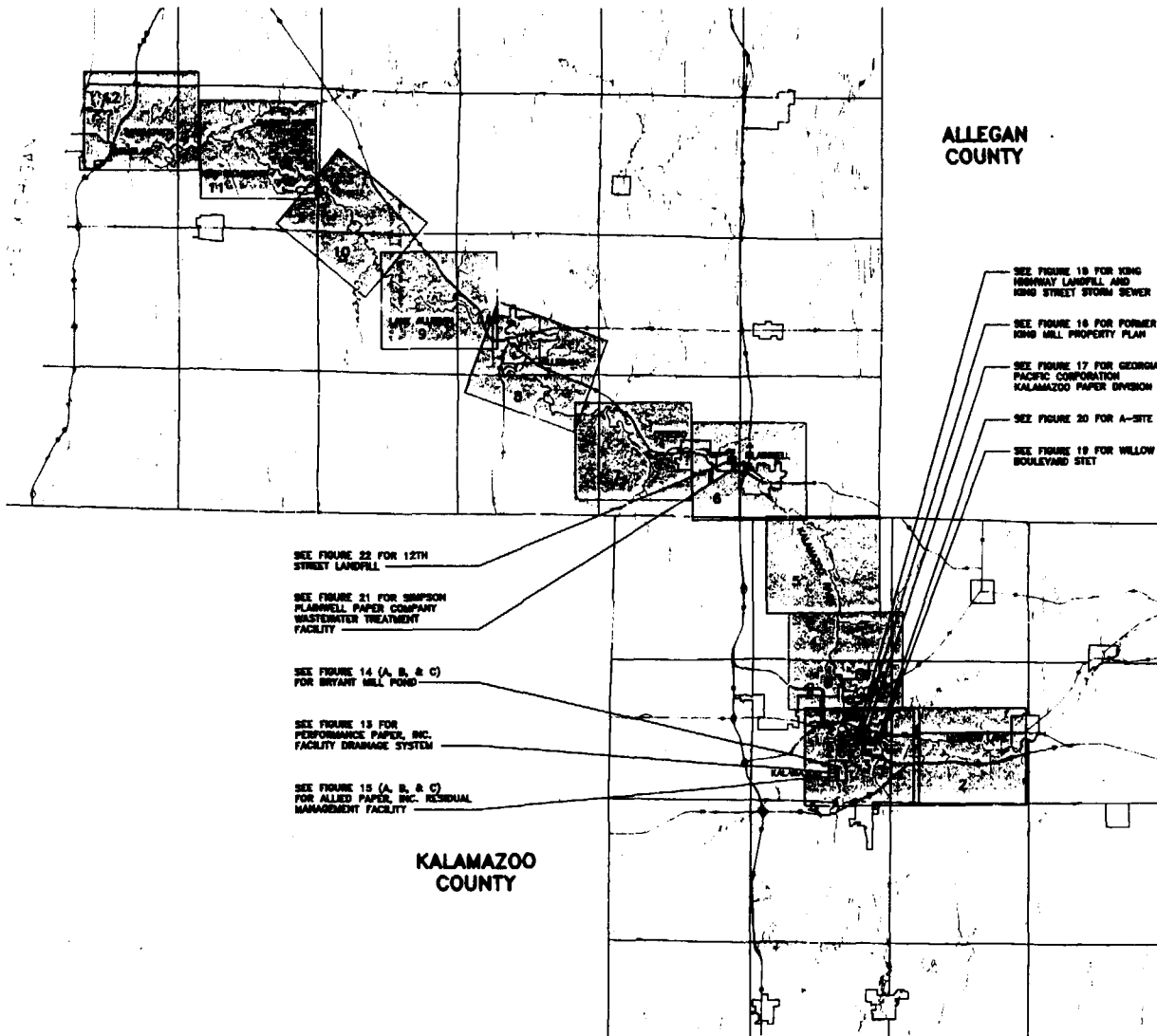
**LOCATION PLAN**

FIGURE

**1**

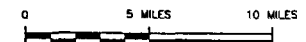
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# **LEGEND**

2 SHEET NO. AND AREA DESCRIBED



SCALE: 1" = 5 MILES

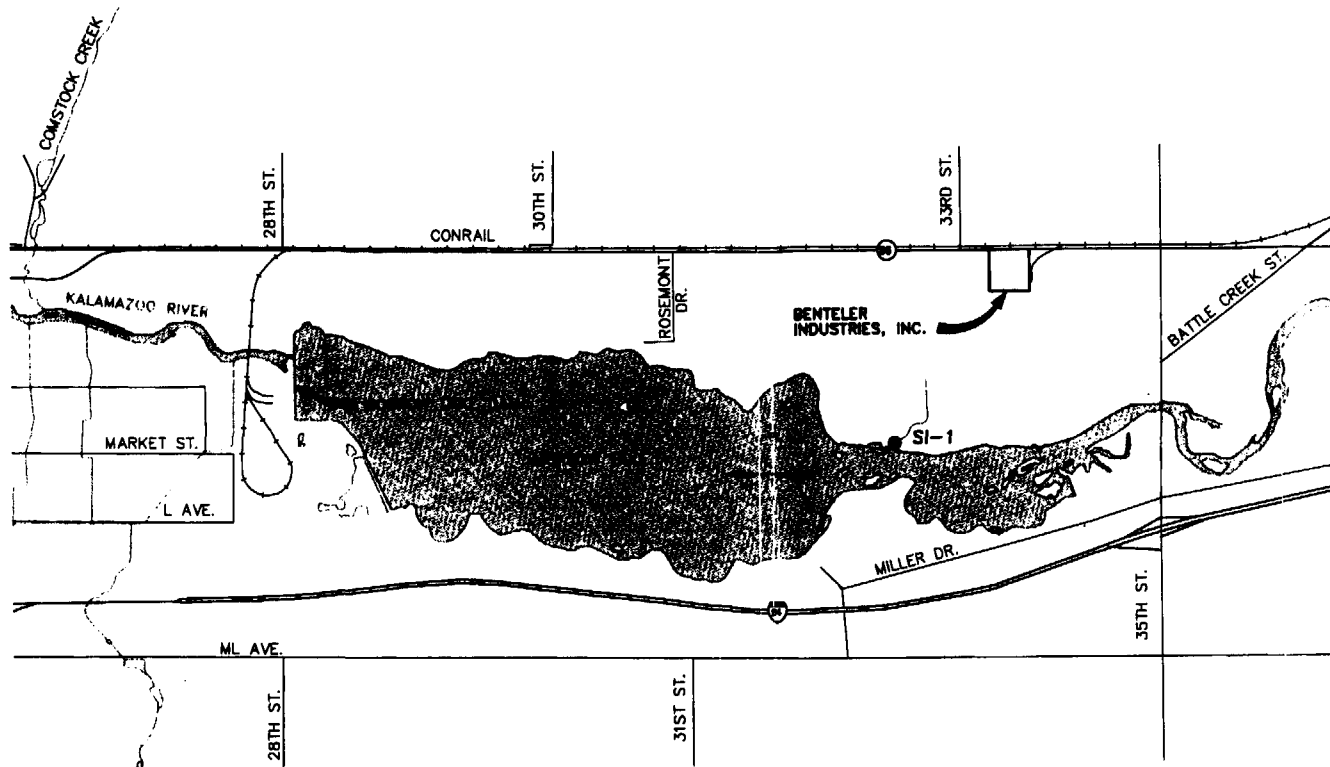
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ALLIED PAPER, INC./PORTAGE CREEK/KALAMAZOO RIVER SUPERFUND SITE  
**RI/FS WORK PLAN**

**INDEX TO DRAWINGS**

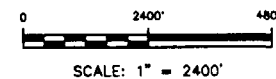
FIGURE  
**2**

KB 511



**LEGEND**

- +—+—+— RAILROAD RIGHT-OF-WAY
- SI-1 ● SOURCE INVESTIGATION SAMPLE LOCATION

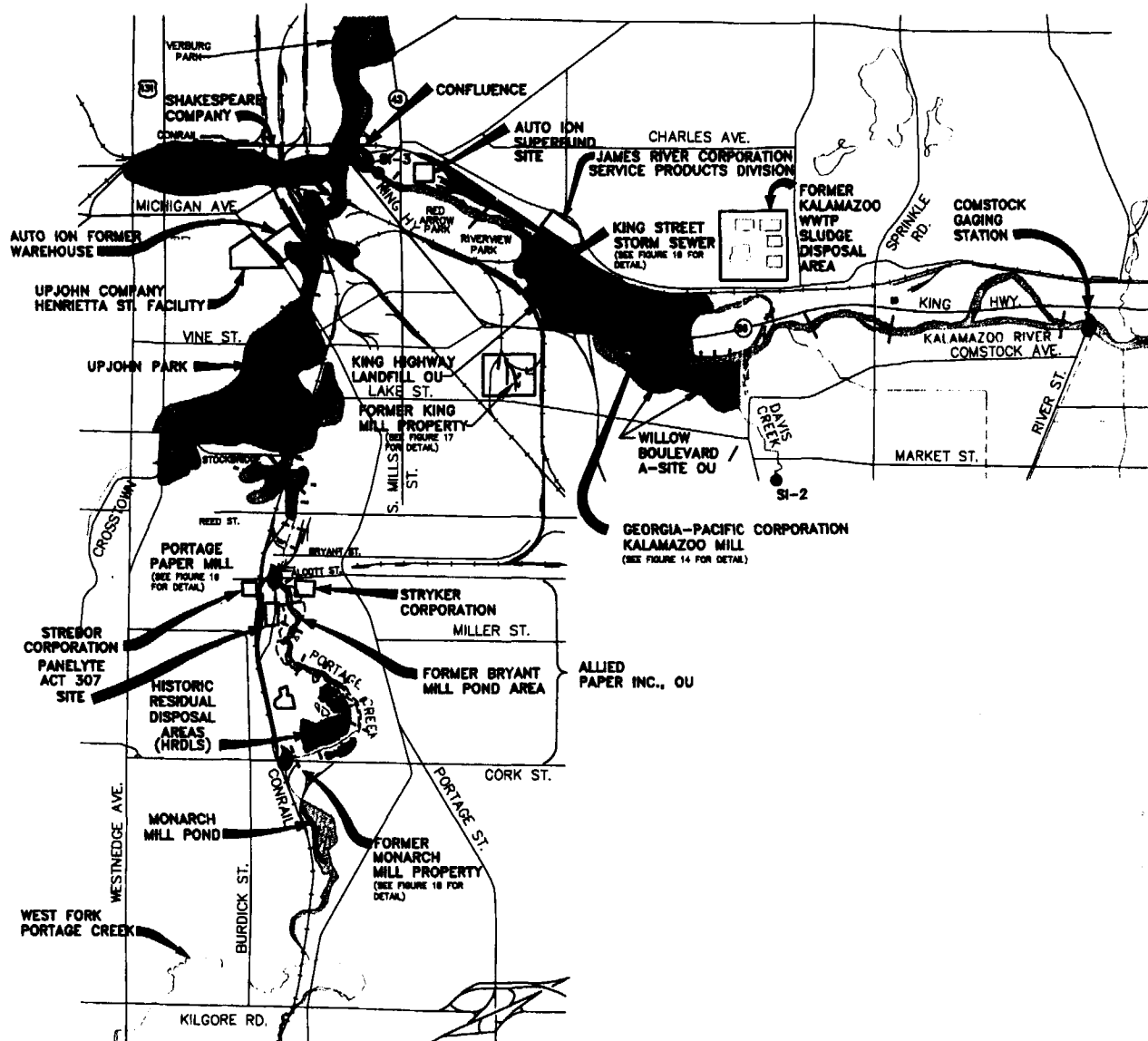


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 ALLIED PAPER, INC./PORTAGE CREEK/KALAMAZOO RIVER SUPERFUND SITE  
 RI/FS WORK PLAN

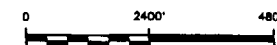
**MORROW LAKE**

FIGURE  
**3**



# **LEGEND**

- RAILROAD RIGHT-OF-WAY
- APPROXIMATE DELINEATION OF PRE-DRAWDOWN CREEK CHANNEL
- APPROXIMATE DELINEATION OF PRESENT CREEK CHANNEL
- SEDIMENT PROBING TRANSECT
- FLOODPLAIN SOIL SAMPLING TRANSECT
- PROPOSED BASE-FLOW AND EVENT-SPECIFIC WATER COLUMN MONITORING LOCATION
- 100-YEAR FLOODPLAIN
- SI-1 SOURCE INVESTIGATION SAMPLE LOCATION



SCALE: 1" = 2400'

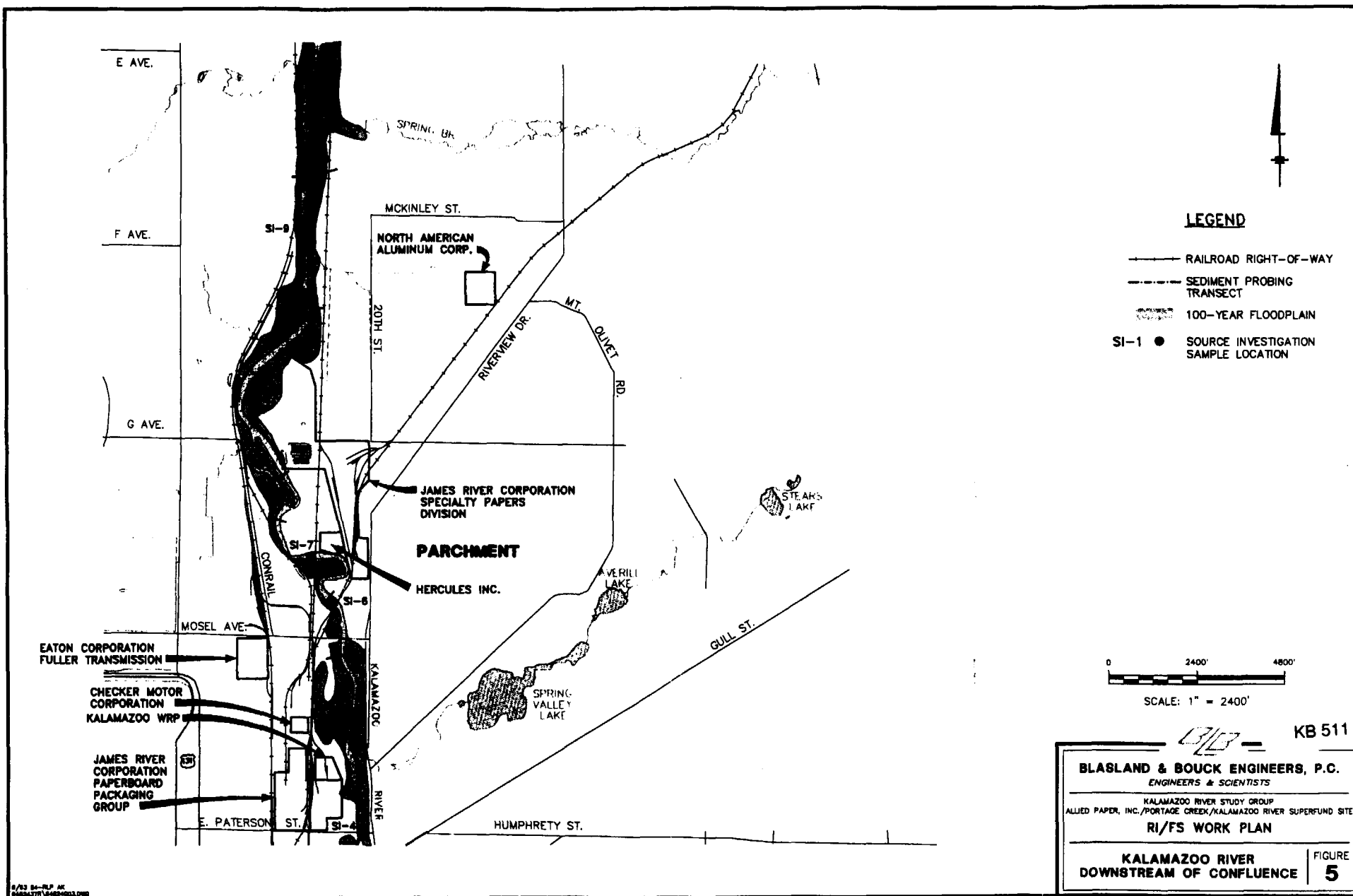
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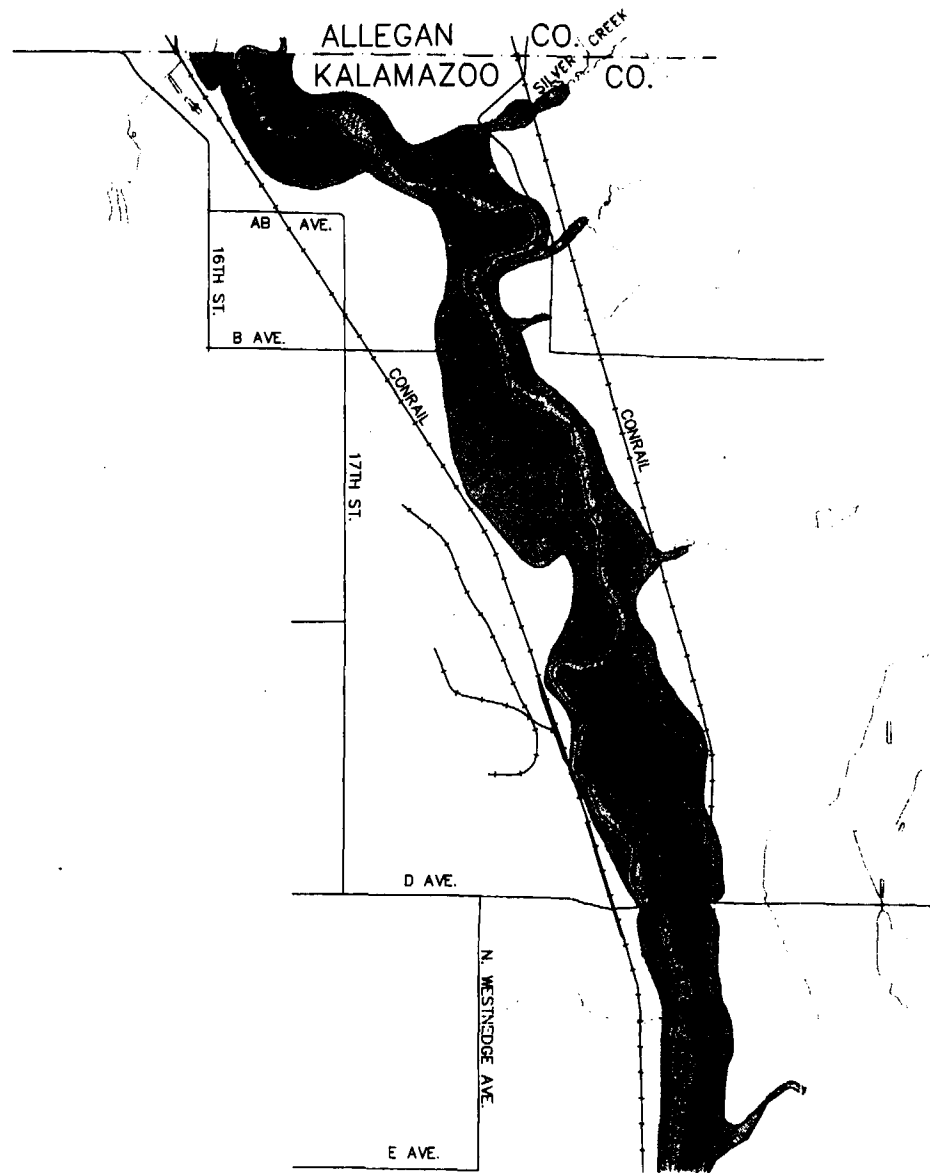
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**RI/FS WORK PLAN**

**PORTAGE CREEK /  
KALAMAZOO RIVER  
CONFLUENCE**

FIGURE  
**4**

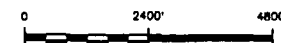
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# **LEGEND**

- RAILROAD RIGHT-OF-WAY
- SEDIMENT PROBING TRANSECT
- FLOODPLAIN SOIL SAMPLING TRANSECT
- PROPOSED BASE-FLOW AND EVENT-SPECIFIC WATER - COLUMN MONITORING LOCATION
- 100-YEAR FLOODPLAIN



SCALE: 1" = 2400'

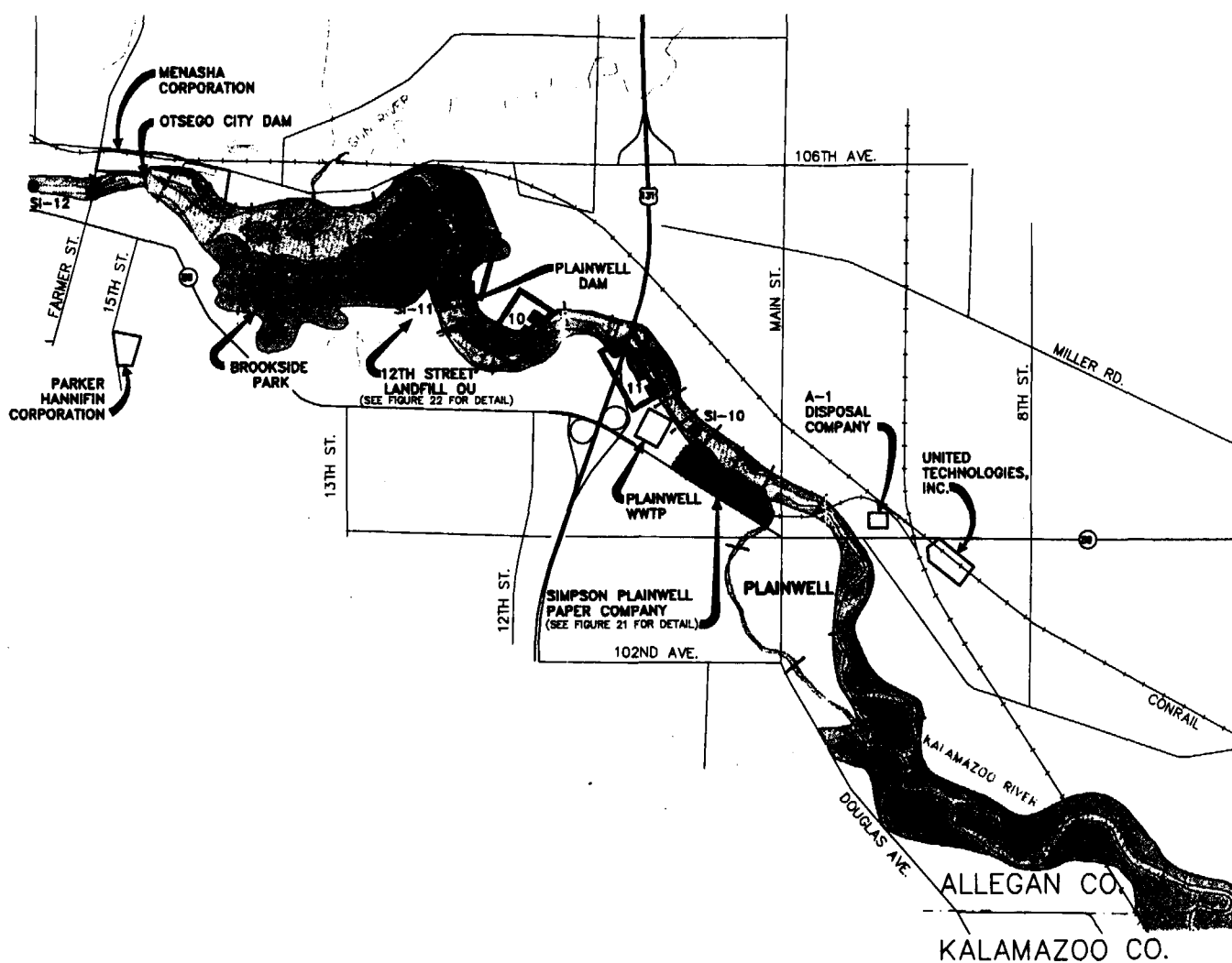
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RI/FS WORK PLAN

**KALAMAZOO RIVER  
UPSTREAM OF PLAINWELL**

FIGURE  
**6**



# **LEGEND**

- RAILROAD RIGHT-OF-WAY
- APPROXIMATE DELINEATION OF PRE-DRAWDOWN CREEK CHANNEL
- APPROXIMATE DELINEATION OF PRESENT CREEK CHANNEL
- SEDIMENT PROBING TRANSECT
- FLOODPLAIN SOIL SAMPLING TRANSECT
- EXPOSED SEDIMENT TRANSECT
- PROPOSED BASE-FLOW AND EVENT-SPECIFIC WATER COLUMN MONITORING LOCATION
- 100-YEAR FLOODPLAIN
- SI-1 SOURCE INVESTIGATION SAMPLE LOCATION
- 10 LOCATION FOR TBSA SCREENING
- CANDIDATE TERRESTRIAL BIOLOGICAL STUDY AREAS (TBSA)



SCALE: 1" = 2400'

KB 511

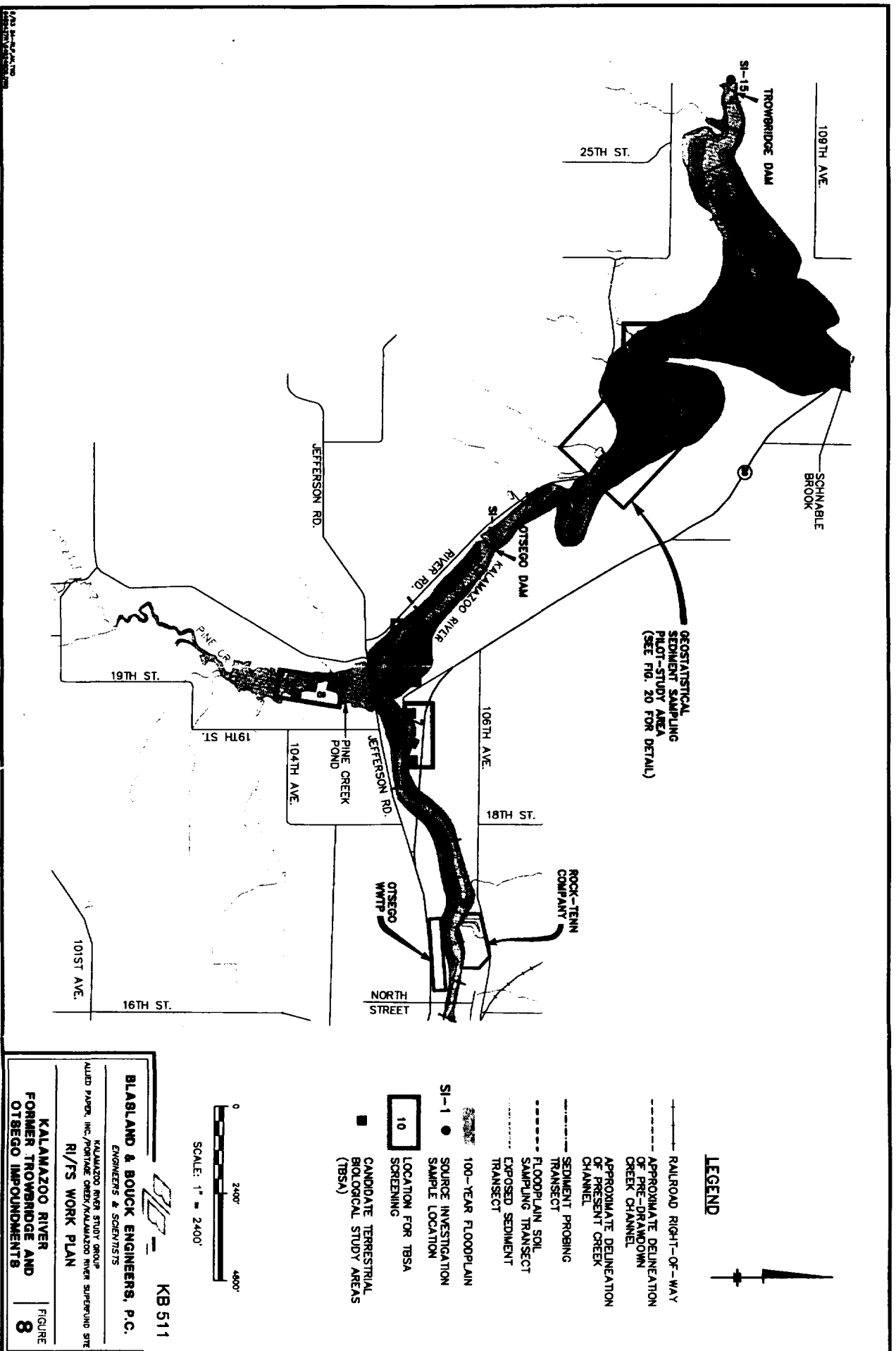
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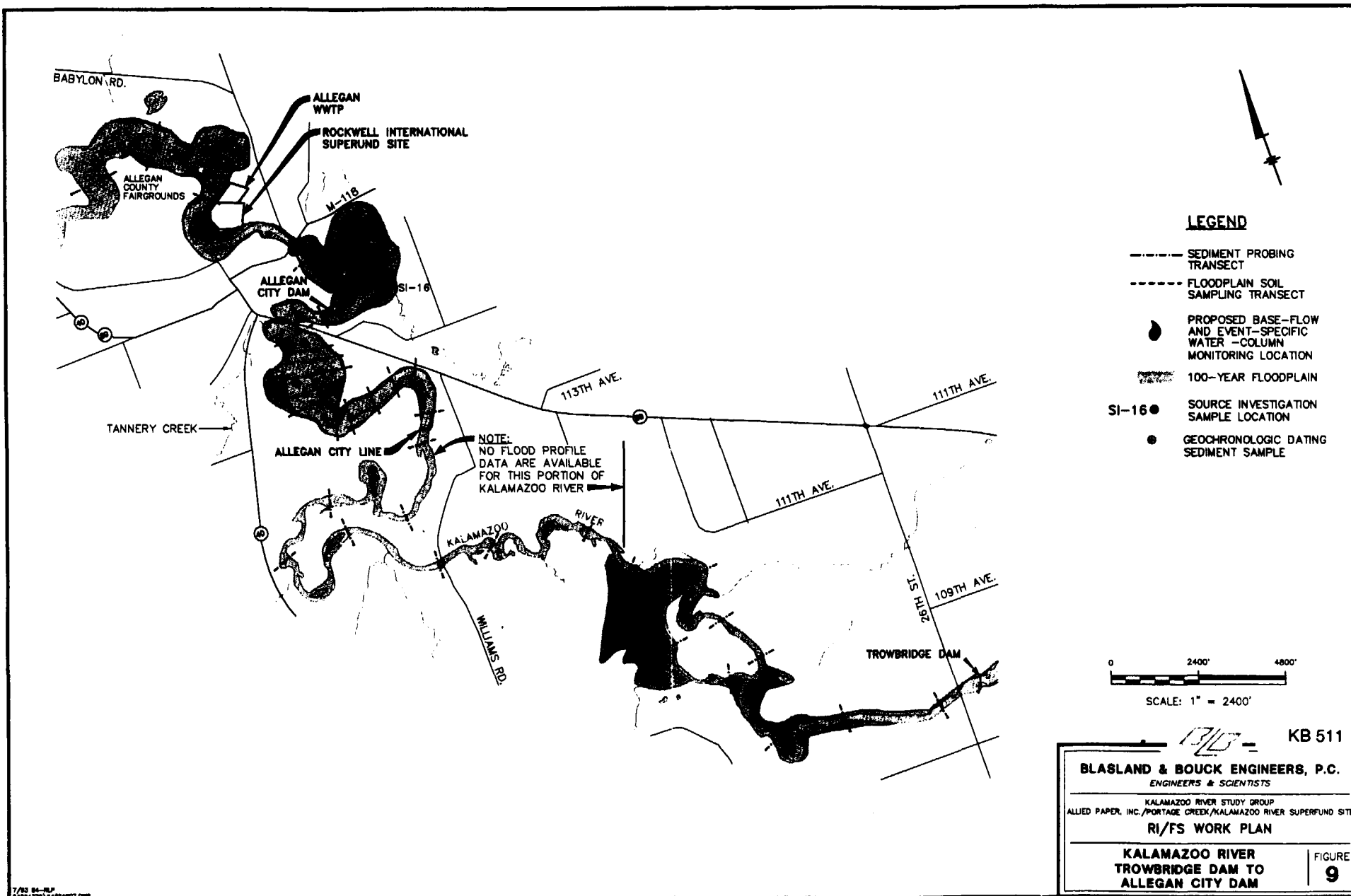
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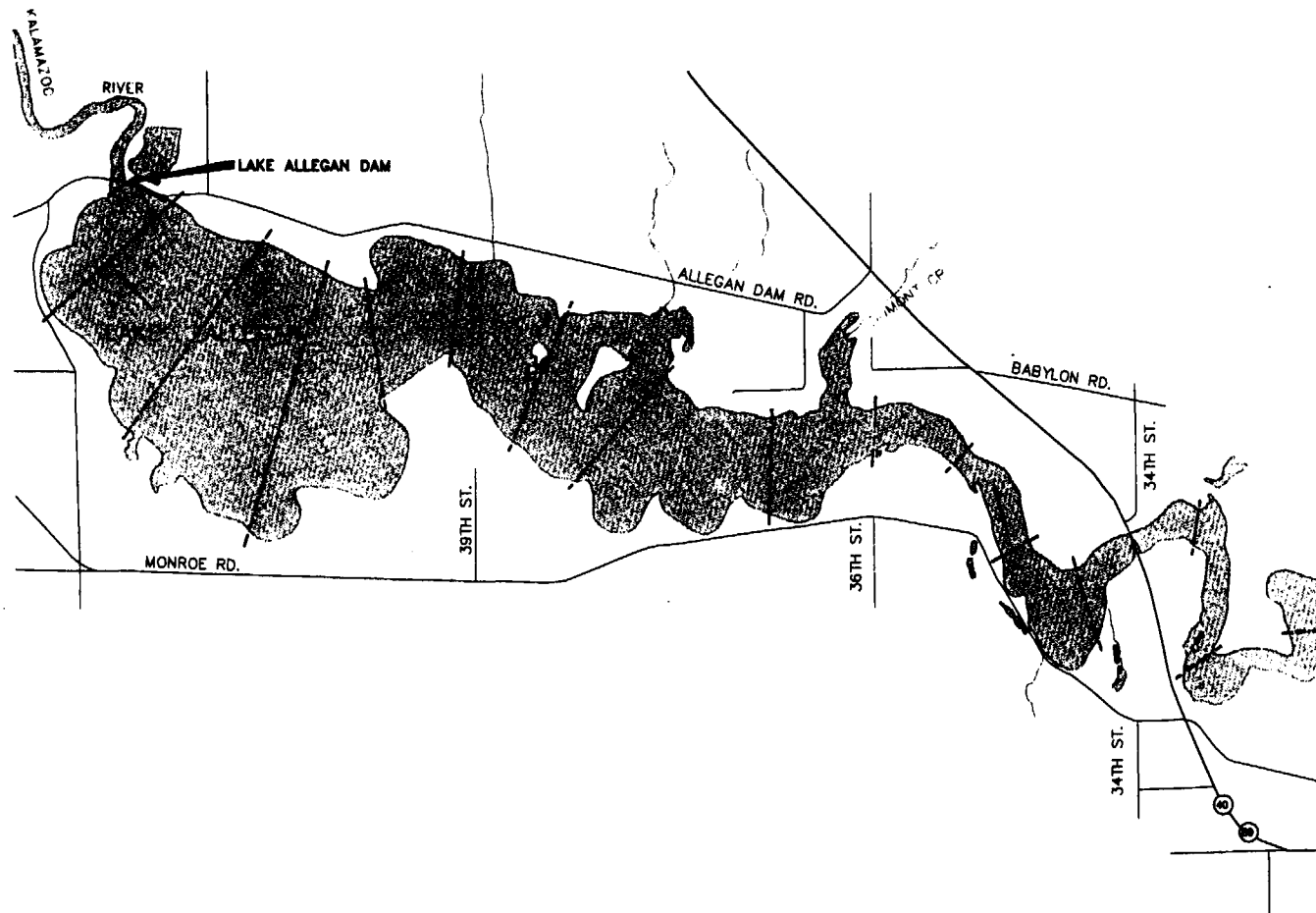
**RI/FS WORK PLAN**

**KALAMAZOO RIVER  
OTSEGO CITY AND  
FORMER PLANWELL  
IMPOUNDMENTS**

FIGURE  
**7**

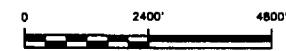






# **LEGEND**

----- SEDIMENT PROBING  
TRANSECT



SCALE: 1" = 2400'

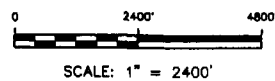
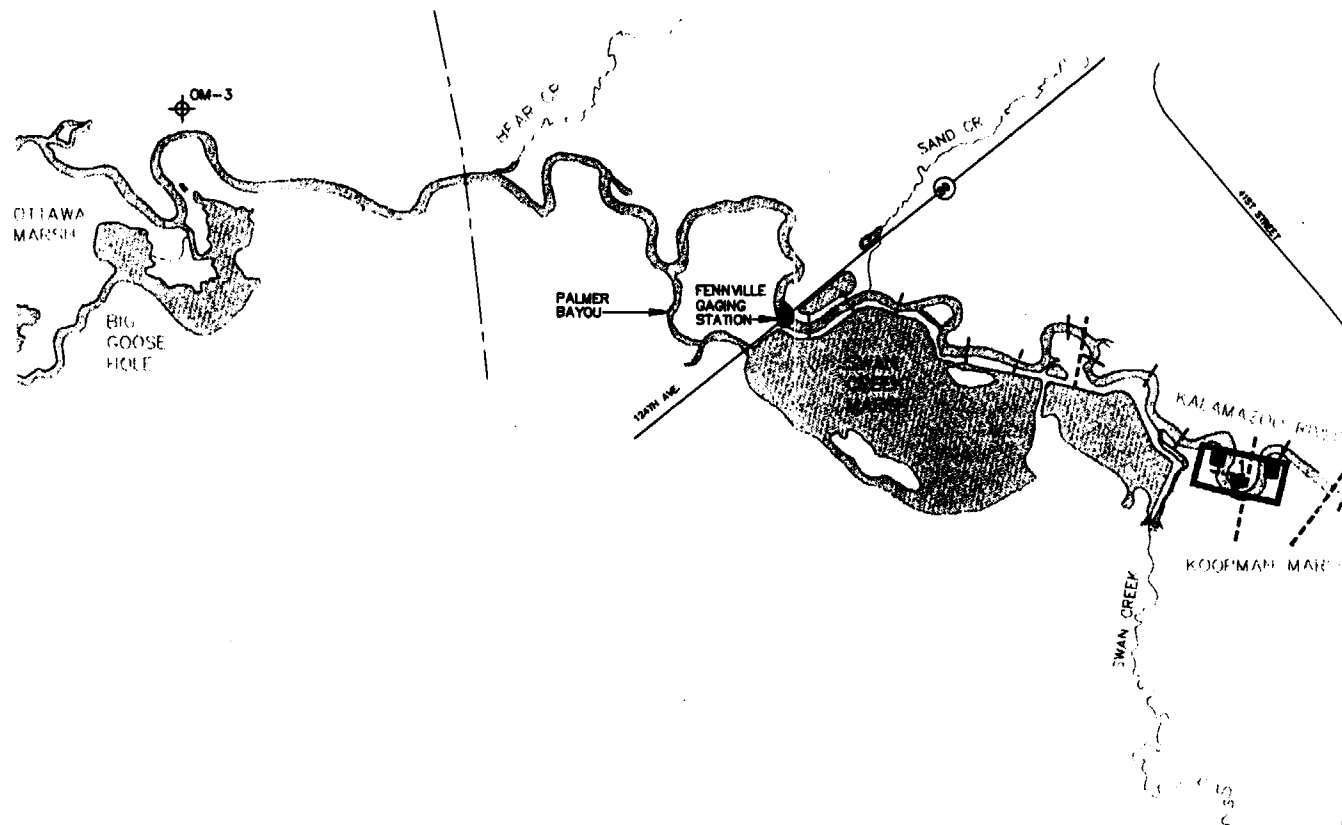
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**RI/FS WORK PLAN**

**LAKE ALLEGAN**

FIGURE  
**10**



**BLG** KB 511

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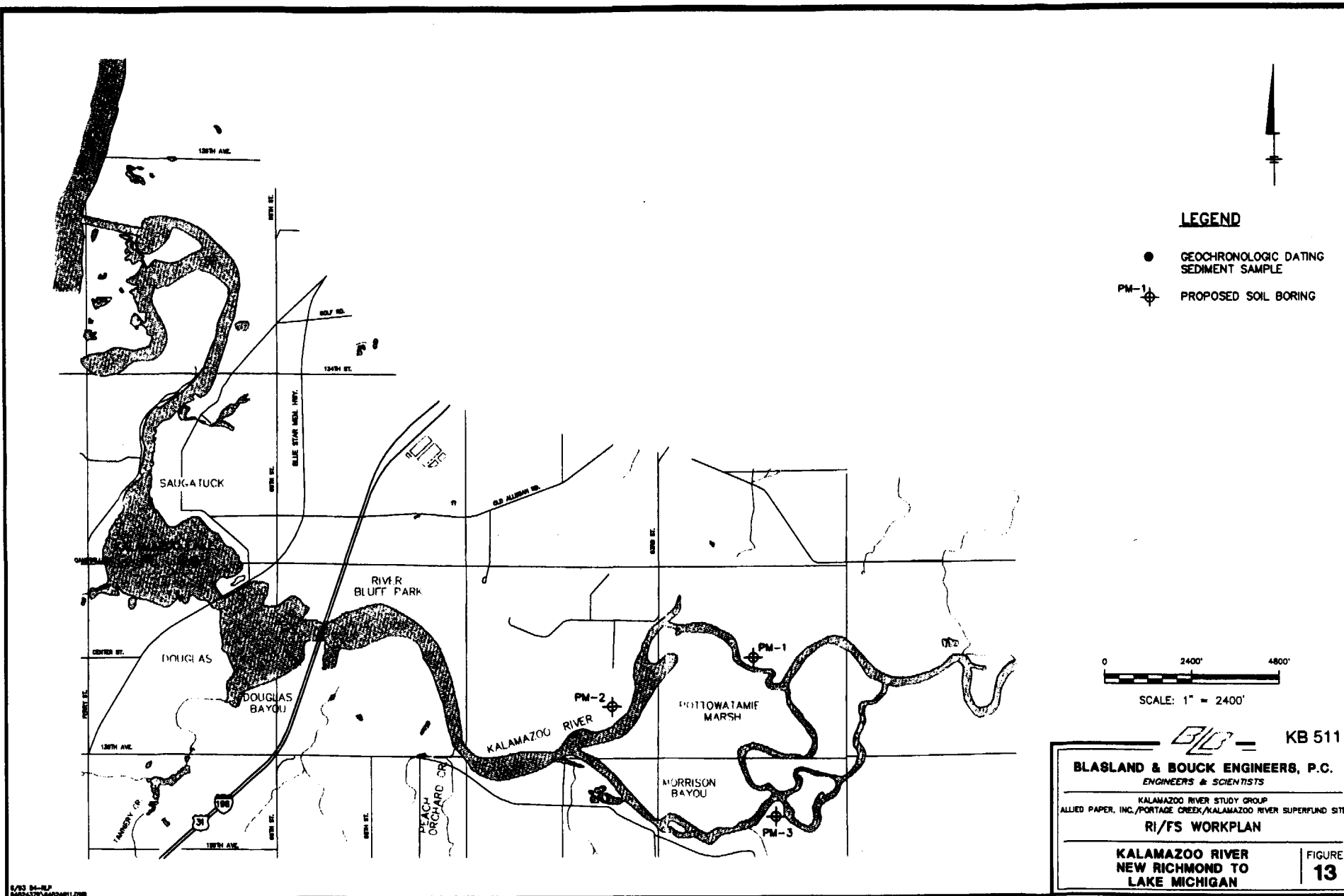
KALAMAZOO RIVER STUDY GROUP  
ALLIED PAPER, INC./PORTAGE CREEK/KALAMAZOO RIVER SUPERFUND SITE

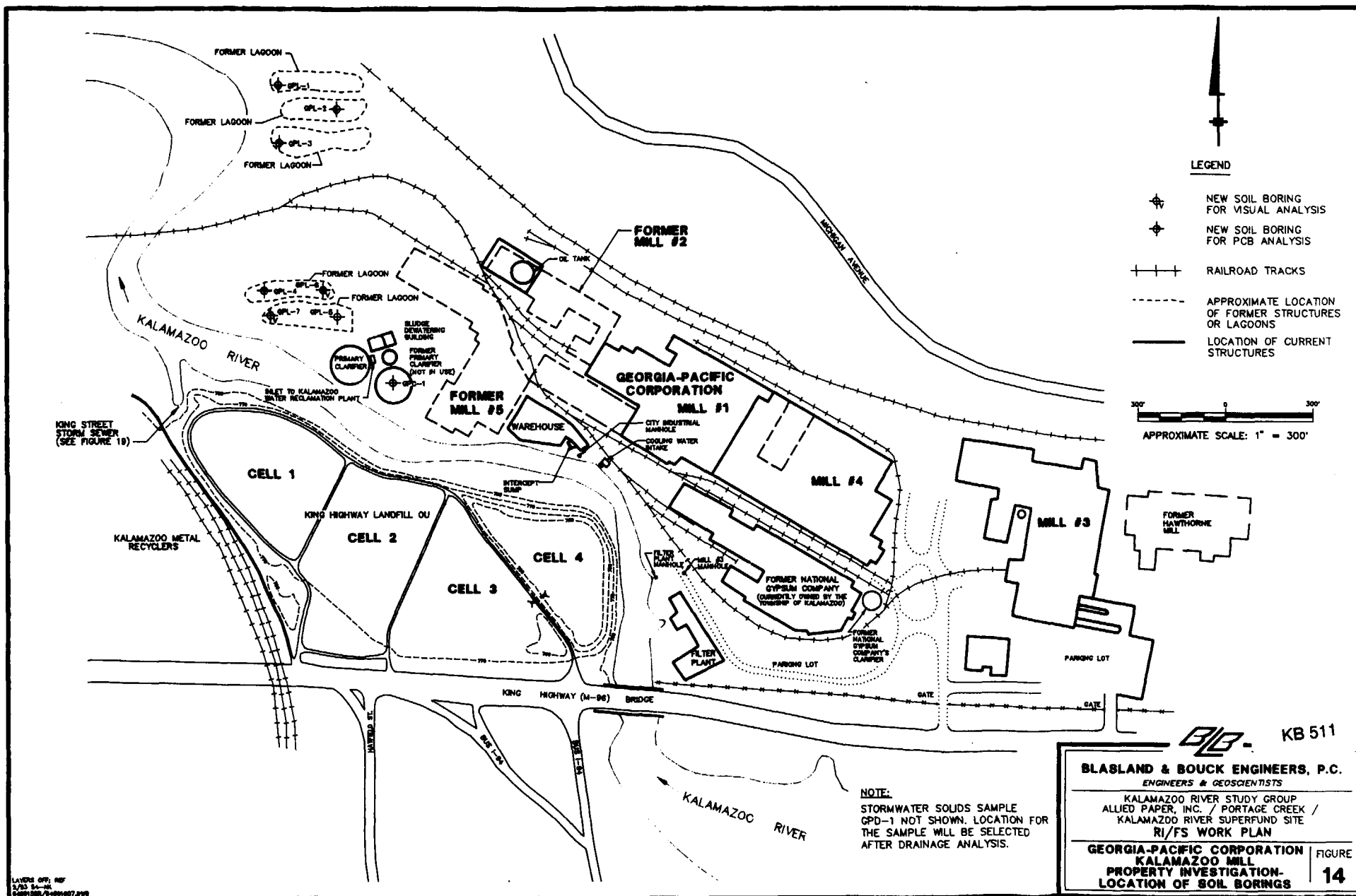
**RI/FS WORK PLAN**

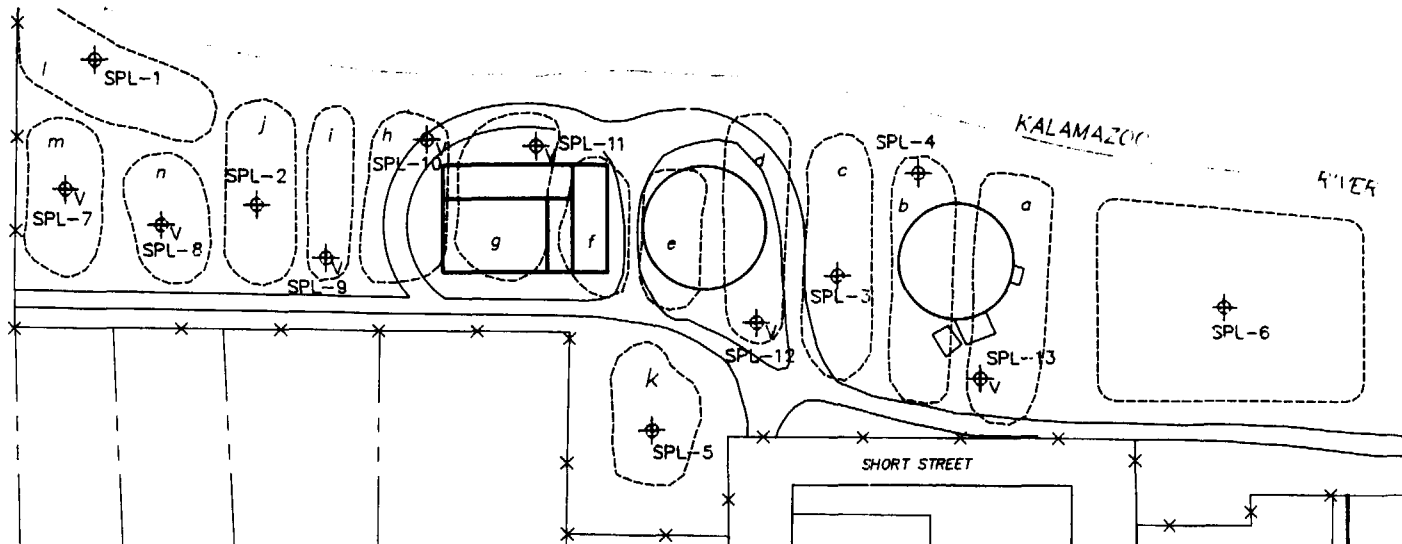
**KALAMAZOO RIVER  
LAKE ALLEGAN DAM  
TO OTTAWA MARSH**

FIGURE  
**11**



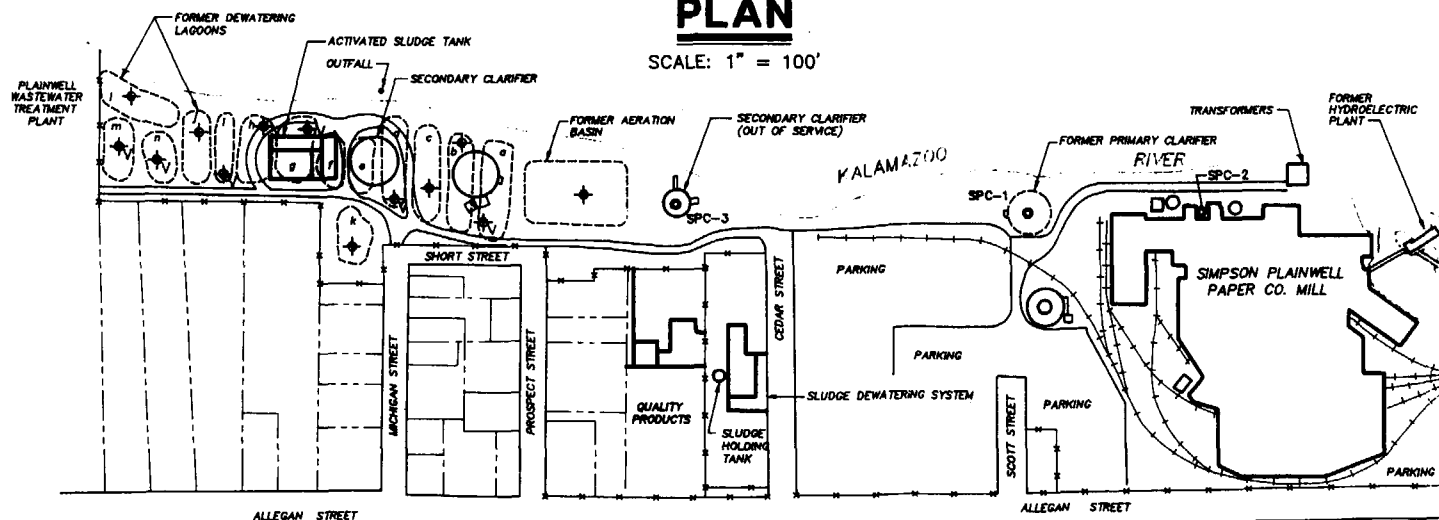






## PLAN

SCALE: 1" = 100'



## PLAN

SCALE: 1" = 250'

### LEGEND:

- FORMER DEINK WASTEWATER DRAIN SOLIDS SAMPLE
- ✦ NEW SOIL BORING
- ✦ NEW SOIL BORING FOR VISUAL ANALYSIS
- FORMER DEWATERING LAGOONS INTERPRETED FROM AERIAL PHOTOGRAPHS (1955, 1960, 1967, 1974, 1981, 1986 AND 1991)
- CURRENT STRUCTURE

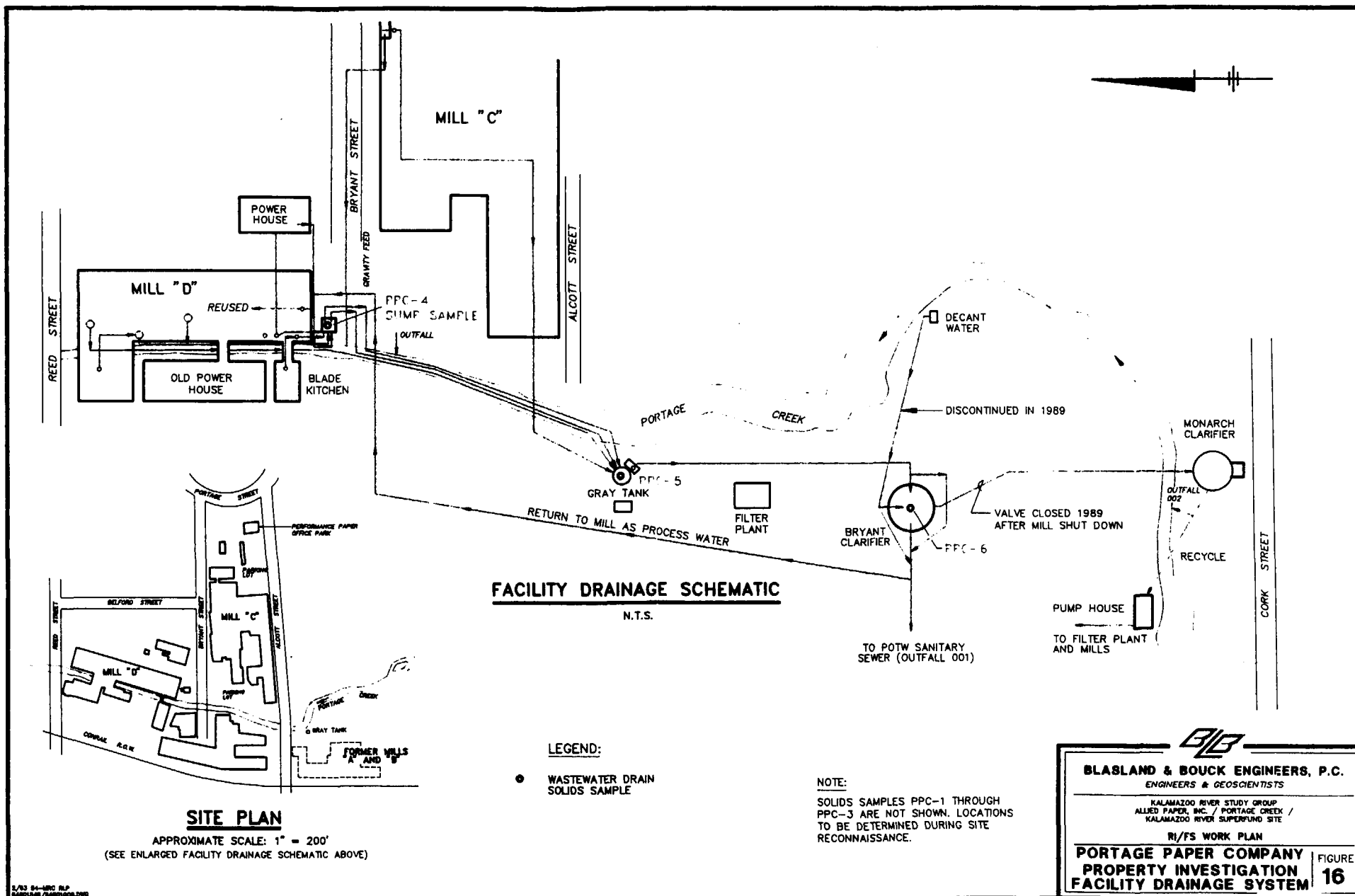
NOTE:  
STORMWATER SOLIDS SAMPLE  
SPD-1 NOT SHOWN. THE  
LOCATION WILL BE SELECTED  
AFTER DRAINAGE ANALYSIS.

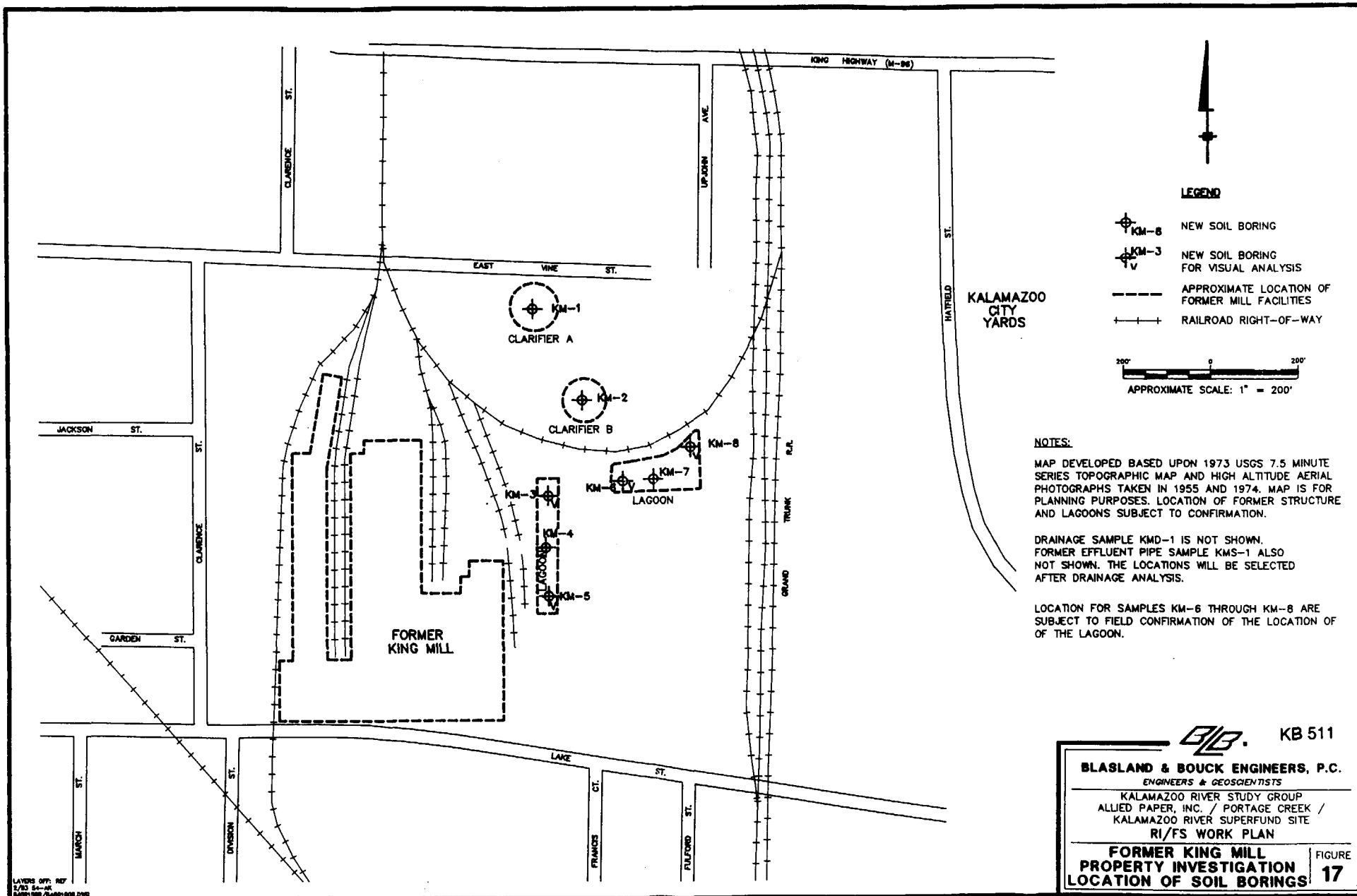
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ENGINEERS & GEOSCIENTISTS

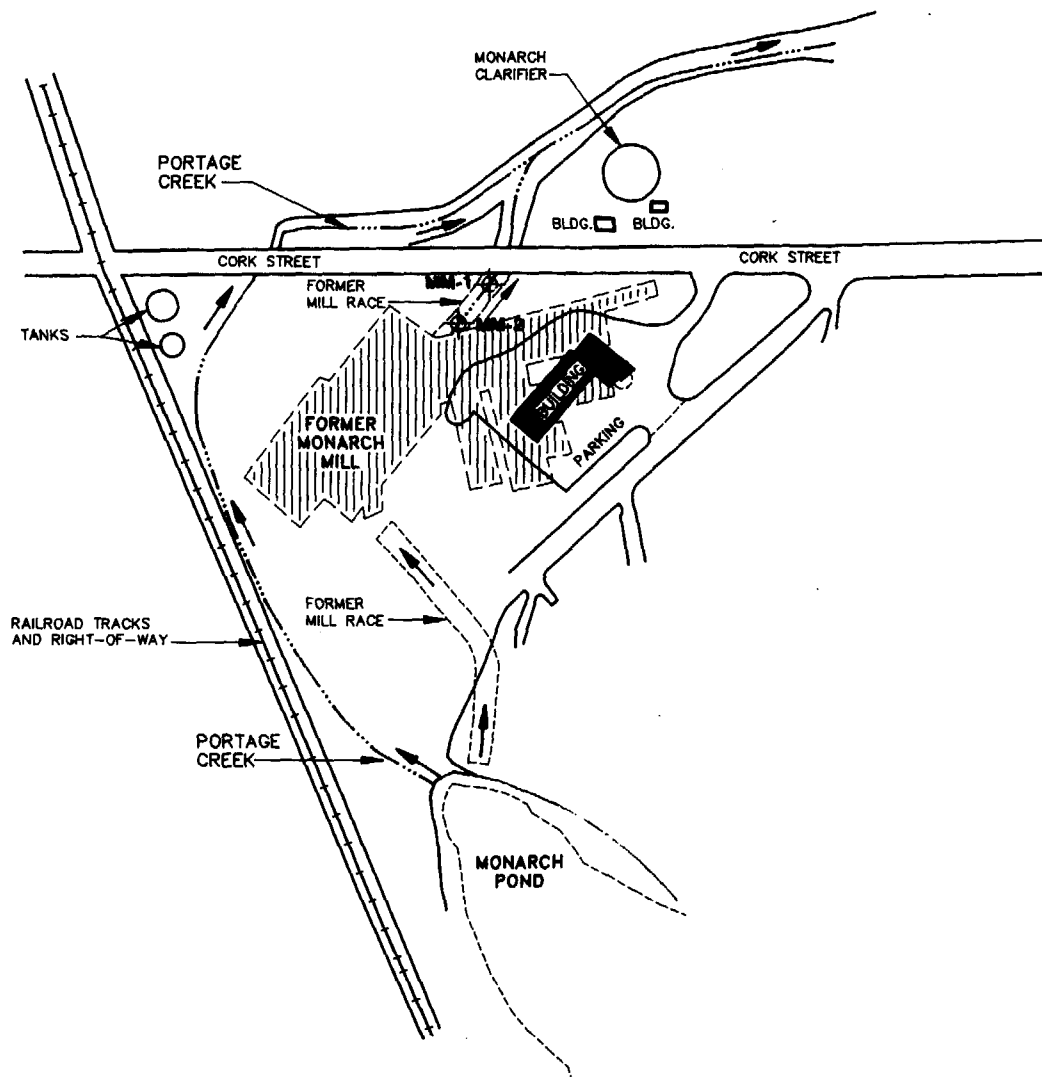
KALAMAZOO RIVER STUDY GROUP  
ALLIED PAPER, INC. / PORTAGE CREEK /  
KALAMAZOO RIVER SUPERFUND SITE  
RI/FS WORK PLAN

**SIMPSON PLAINWELL PAPER CO.**  
MILL INVESTIGATION-  
LOCATION OF SOIL BORINGS

FIGURE  
**15**







# **LEGEND**



- NEW SCIL BORING LOCATION
- FEATURES PRESENT ONLY ON 1955 AERIAL PHOTOGRAPH
- FEATURES PRESENT ON 1991 AERIAL PHOTOGRAPH



APPROXIMATE SCALE: 1" = 200'

## **NOTE:**

BASE MAP PREPARED USING  
4/17/91 AND 7/12/55  
AERIAL PHOTOGRAPHS.



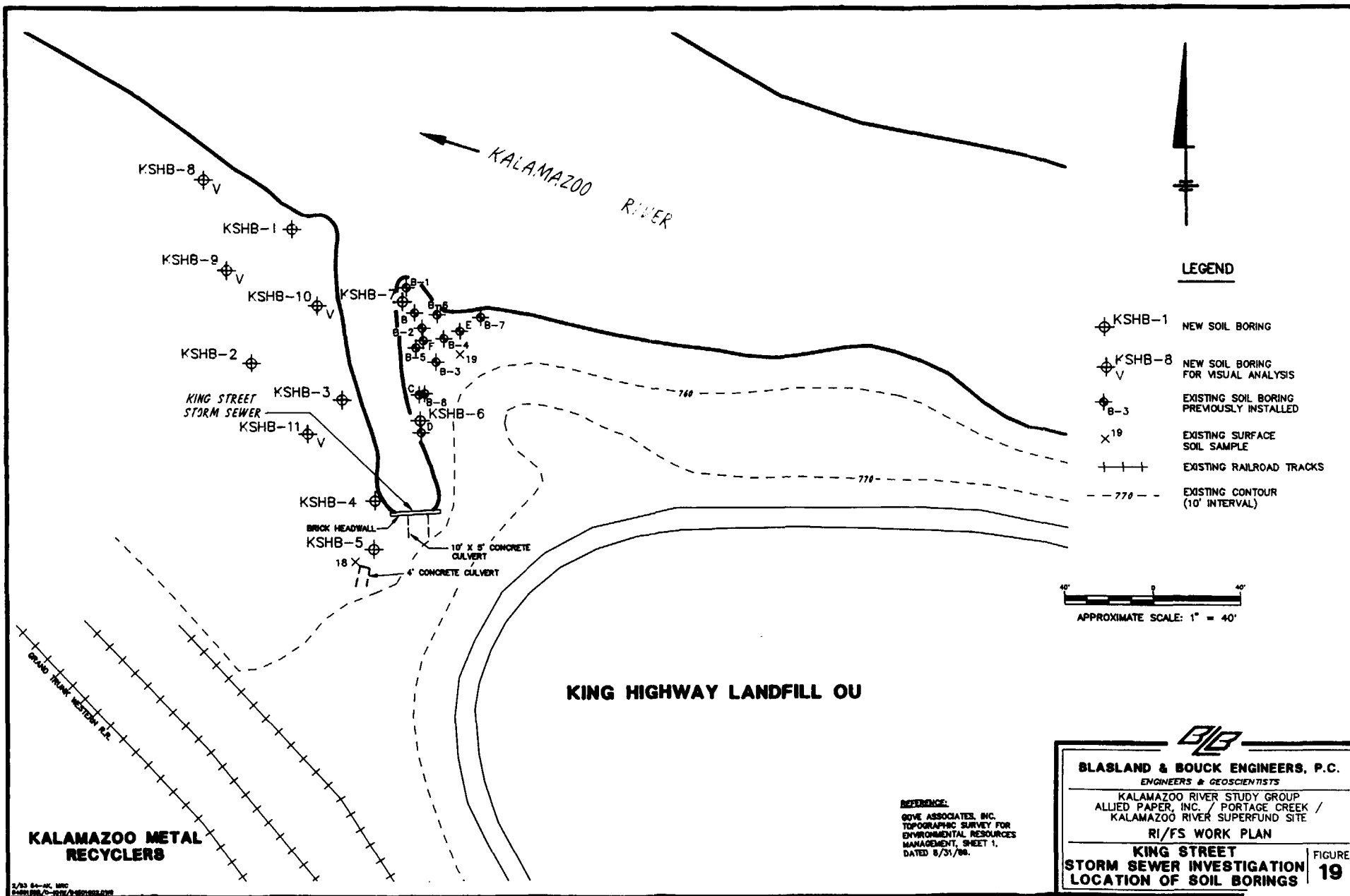
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RI/FS WORK PLAN

**FORMER MONARCH MILL  
PROPERTY INVESTIGATION  
LOCATION OF SOIL BORINGS**

FIGURE  
**18**





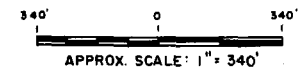
JAN. 1992  
645.01.59

FIGURE 10



**LEGEND**

- SEDIMENT SAMPLING SITES



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STUDY GROUP

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KALAMAZOO RIVER SUPERFUND SITE

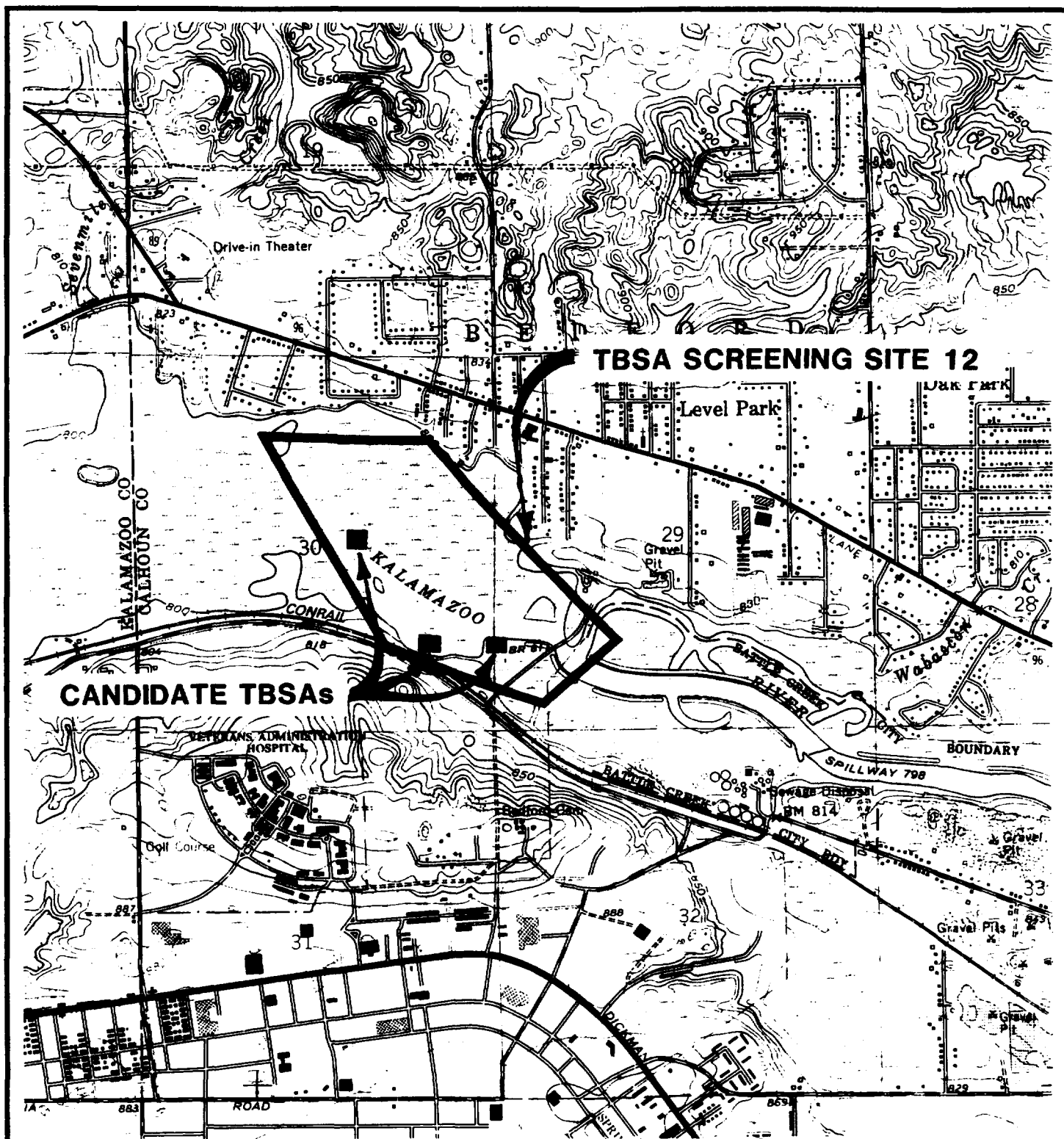
SEDIMENT SURVEY  
PILOT STUDY

**PROPOSED  
SAMPLING DESIGN**

KB 511



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REFERENCE: AUGUSTA, MICH. USGS QUAD. 1985  
2000' 0 2000'

APPROX. SCALE: 1" = 2000'



FEB. 1993  
645.01.59



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KALAMAZOO RIVER RI/FS WORKPLAN

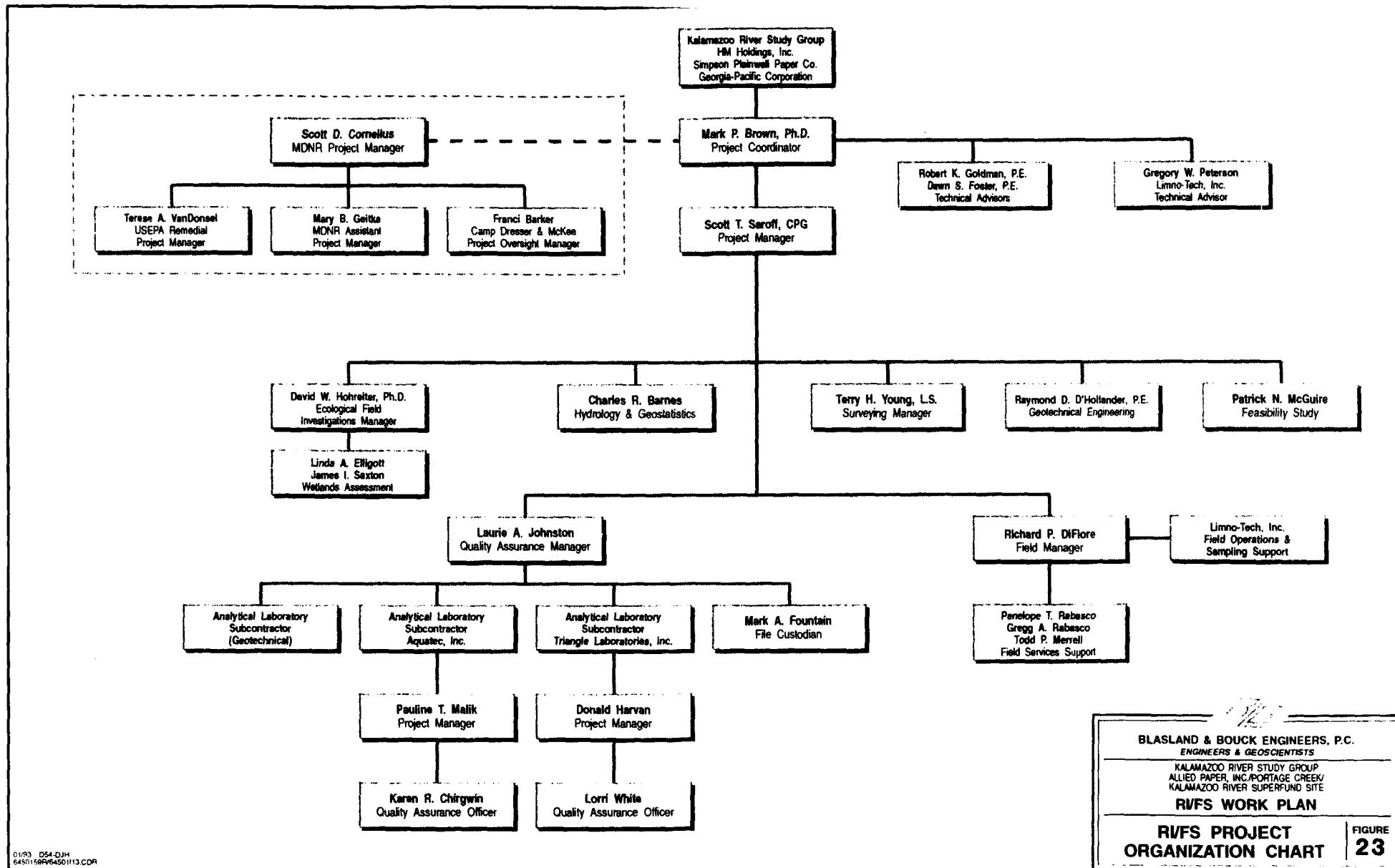
**PROPOSED TERRESTRIAL  
BIOLOGICAL STUDY AREAS  
NEAR FORT CUSTER STATE  
RECREATION AREA**

FIGURE

**21**

KB 511







## Appendices

**APPENDIX A**

**Proposed Geostatistical Sediment Sampling**  
**Pilot Study**

**Proposed Geostatistical Sediment Sampling  
Pilot Study**

In response to MDNR's request that a pilot study be conducted as part of the RI to evaluate the merits of a geostatistical sampling design and analysis approach, the KRSG proposed the following pilot study plan. The study presented here, offers the advantages of allowing the assessment of correlation structure in meandering and straight sections of the River free of the possible complications of nearby potential point-sources. The proposed sampling design also offers coverage statistically equal to MDNR's proposal to distances of 2000 feet with specific advantages in several respects including:

- a more uniform distribution of sample pair distances;
- more accurate definition of the expected nugget effect; and,
- a more thorough assessment of anisotropy.

This plan is presented in response to MDNR's request that the KRSG conduct a pilot study as part of the RI to evaluate the merits of a geostatistical sediment sampling and analysis strategy. This plan is a modification of MDNR's guidance for performing the geostatistical sediment sampling pilot study (Cornelius, 1992d). As discussed during a December 3, 1992 meeting with MDNR, the KRSG had concerns regarding several aspects of MDNR's November 19, 1992 guidance on the design of the pilot study including proximity of potential point sources of PCB to the study area; the coarseness of sampling grid for development of variogram; and, lack of sufficient lateral sampling to

assess anisotropy. MDNR and USEPA expressed a willingness to review an alternate proposal that would be equivalent in assessing the utility of the geostatistical approval. The proposed study presented here is, with minor modifications suggested by MDNR, the study proposed by KRSR on December 8, 1992 (Brown, 1992c).

The river segment proposed for the Geostatistical Pilot Study is a 1-mile segment upstream of the former Trowbridge Dam (Figure A-1). This segment has been selected because it contains both straight and meandering sections and contains no adjacent potential point sources of PCBs. Statistically, this will allow for characterization of hydraulically-controlled variability not influenced by possible nearby sources of PCBs. This should eliminate the necessity of detrending a non-random component of the statistical variance.

The proposed sampling design for the pilot study is shown in Figure A-2. A total of 62 sampling locations are proposed. At each sampling locations a sediment core sample will be collected. The goal of the sampling will be to obtain a core which passes through PCB-containing sediment. A minimum core depth of three feet is an objective but may not be obtainable at all locations. The location, depth of water, depth of core and a lithologic description will be noted for all cores. Samples for analysis of PCBs will be taken from the upper 1-foot interval and lowest one-foot interval above any identifiable residual/native soil interface of each core. If no interface is identifiable, the sample will be taken from the lowest 1-foot interval of the core. Photographs will be taken of each core sample.

Our approach to this geostatistical pilot study is consistent with the design recommendations provided by Flatman et al. (1988) (reference provided to MDNR at the December 3, 1992 meeting). The intent of this initial phase of sampling is the development of a variogram based on a relatively dense series of sampling points near the center of the study segment and progressively fewer sample locations radially away from the center. This strategy will provide a more accurate definition of the nugget and sloping portion of the variogram without an excessive number of sampling pairs beyond the probable range of correlation. The number of sample pairs which can be used to develop the variogram, needed for determination of proper grid spacing if a full-scale geostatistical sampling effort is selected, are shown in Figure A-3 for a 1000-foot range and in Figure A-4 for a 3000-foot range. This plan maintains approximately the same number of pairs for distances up to 2000 feet (Figure A-5) as MDNR's November 19, 1992 guidance.

The second advantage of the KRSG proposal is that since it incorporates more lateral cross-section sampling, more accurate characterization of the suspected strong anisotropy of the River can be made. This would be used to develop a variogram and select grid spacing normal to the direction of flow. The proposed plan include 174 lateral sample pairs compared to 87 indicated in the MDNR's November 19th guidance (Figure A-6). This proposed study includes three cross sections with five or more samples taken in the transect and 18 pairs of sediment samples less than 50 foot apart.

PCB data collected during the geostatistical sediment sampling pilot study will be analyzed by the GeoEAS software (England and Sparks, 1988). The primary objectives of the geostatistical pilot study will be the development of a variogram to describe the spatial variability of PCB concentrations in the River and to assess the implication of various sampling densities on the reliability of future mapping activities. In addition to PCB concentration data, depth of sediment may also be analyzed by geostatistical techniques. Results of the sediment characteriation and geostatistical pilot studies will be reviewed to determine the best design for a Phase II sediment sampling program to meet the objective of alternative assessment during the RI.

In summary, the proposed study will satisfy the goal of the geostatistical pilot study and provides equal total coverage with a more uniform distribution of paired sample distances within the probable range of correlation, ability to define the variogram nugget, and ability to assess lateral anisotropy than the original MDNR November 19, 1992 design.

FIGURE A-1

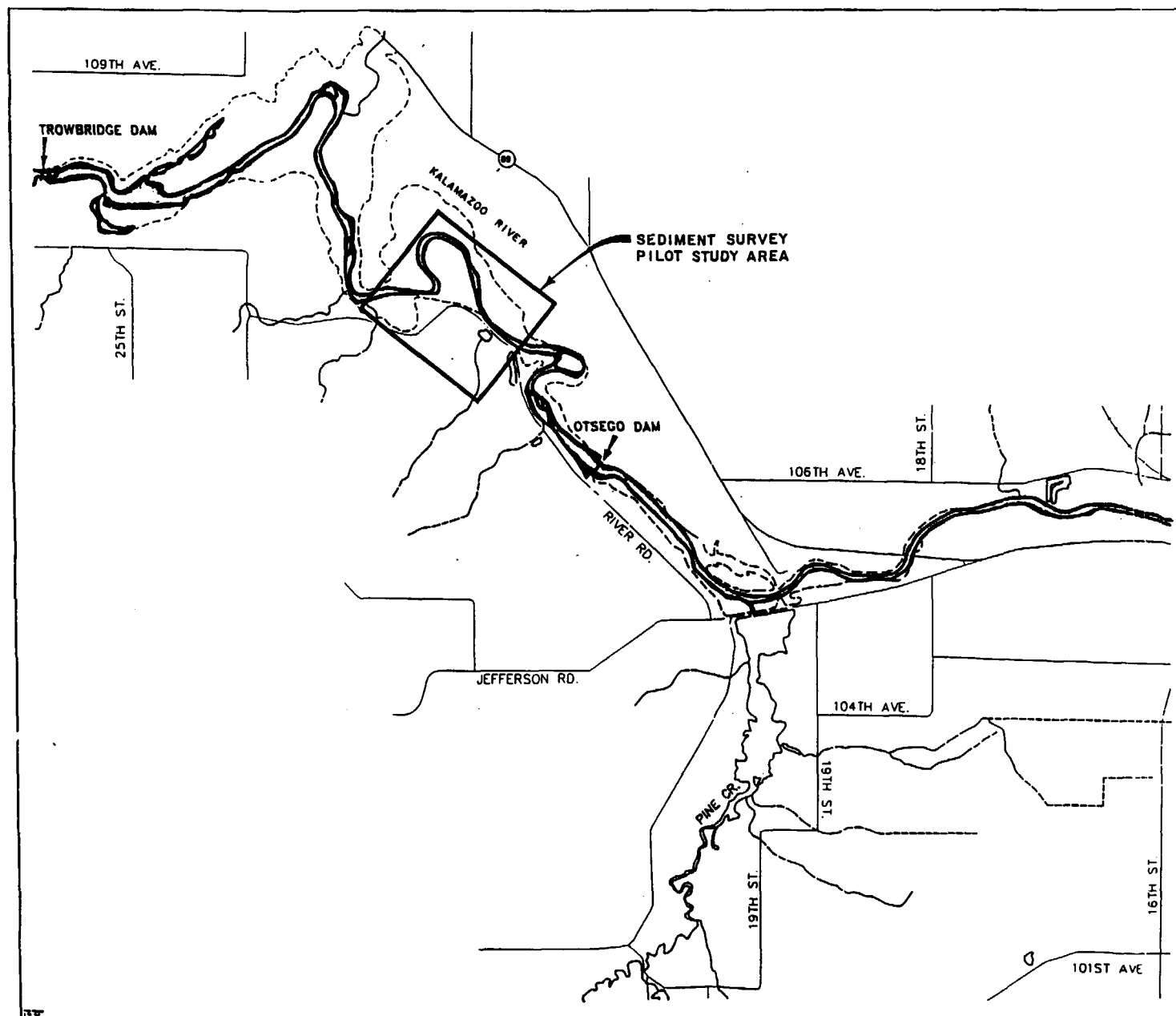
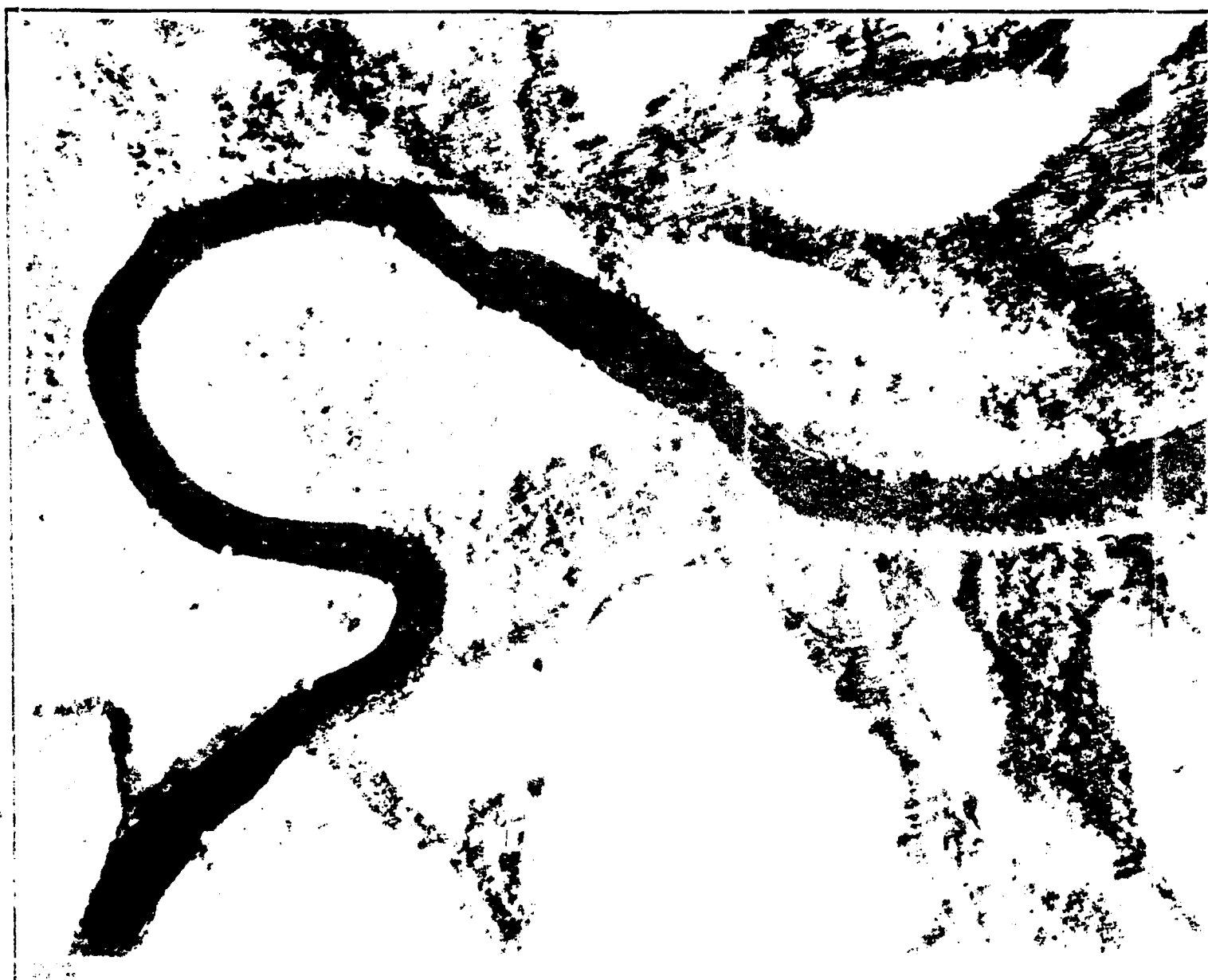


FIGURE A-2



LEGEND

- SEDIMENT SAMPLE SITES



KALAMAZOO RIVER  
STUDY AREA

ALLIED PAPER, INC. / PORTLAND CEMENT  
KALAMAZOO RIVER TREATMENT SITE

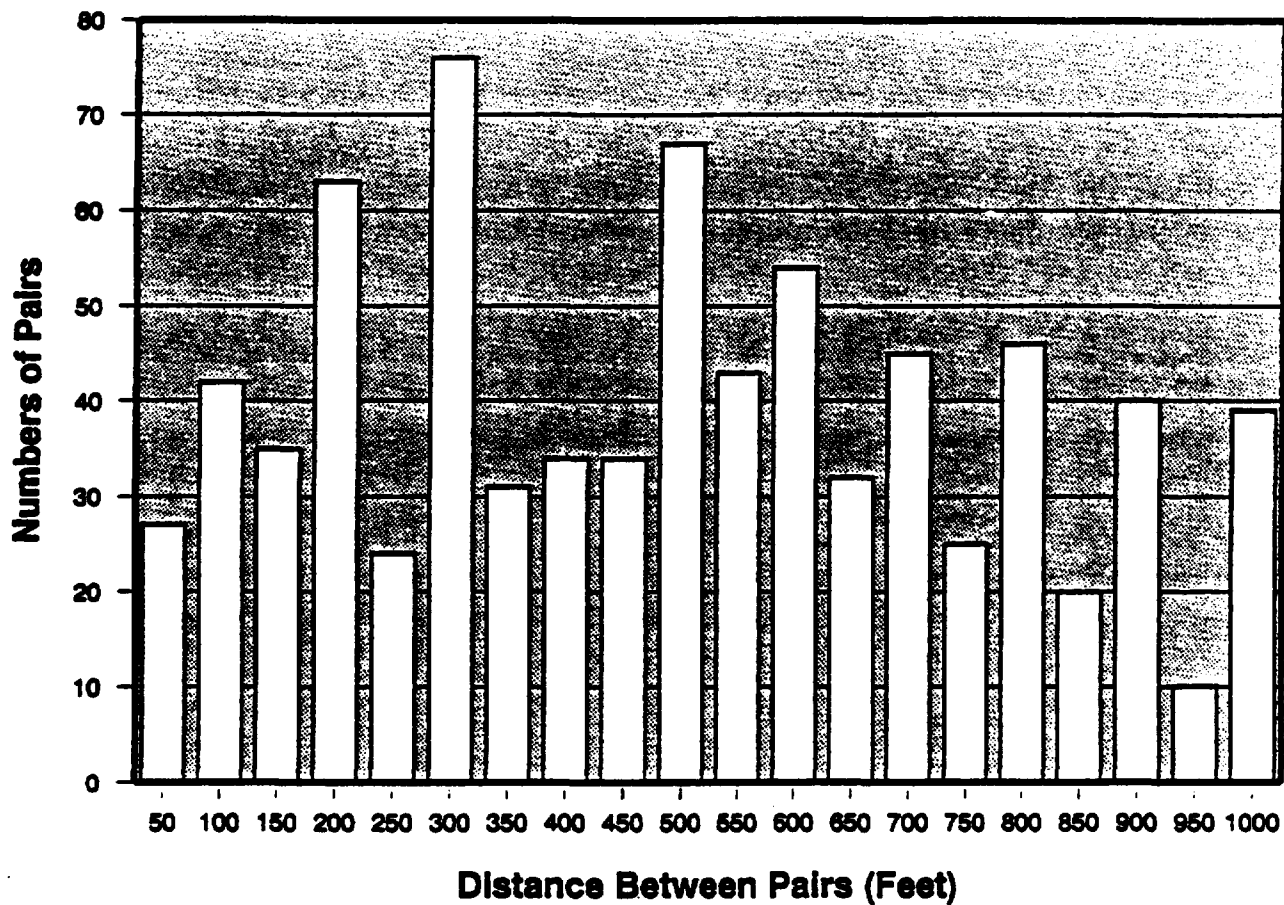
SEDIMENT SURVEY  
PILOT STUDY

PROPOSED  
SAMPLING DESIGN

KB 511



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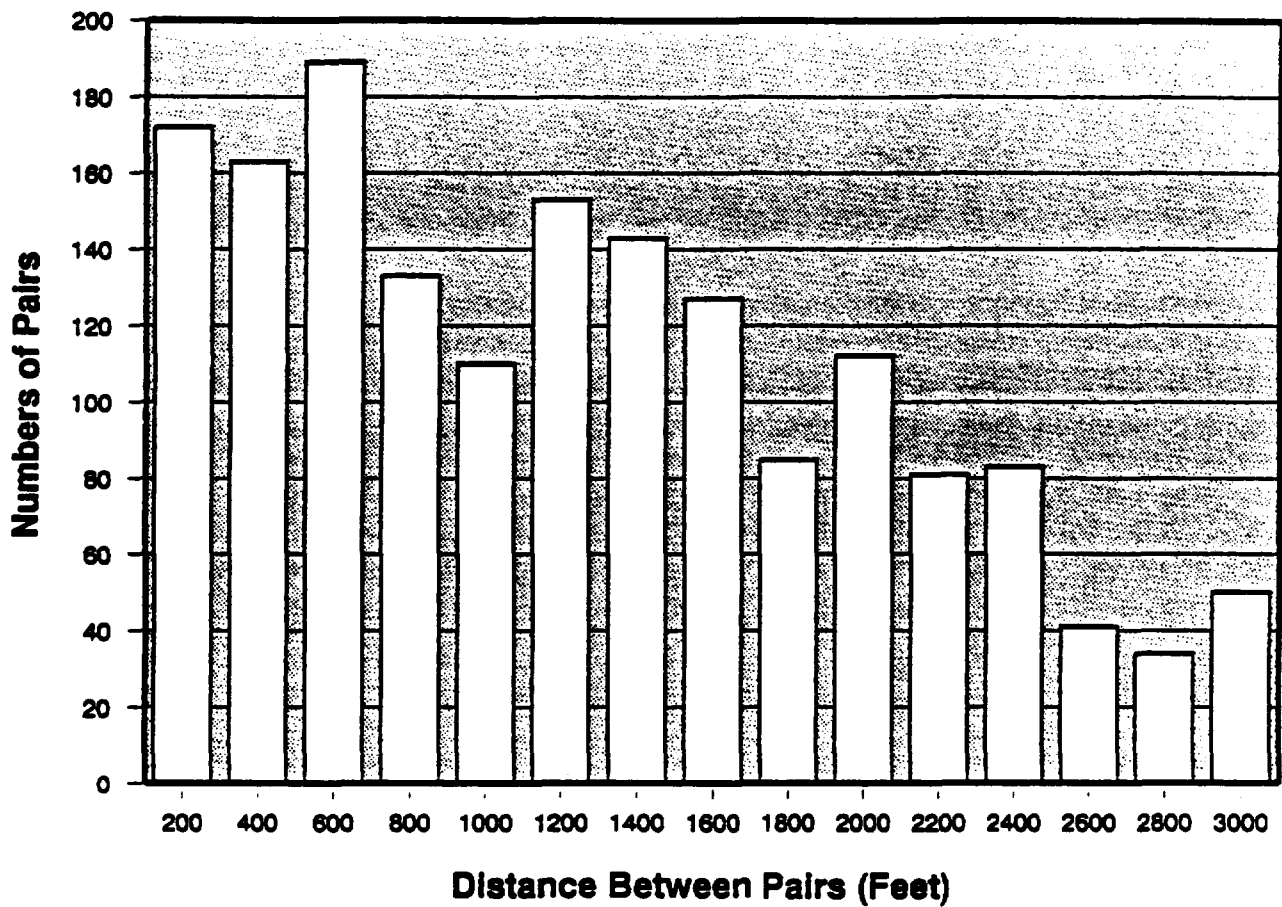
KB 511

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KALAMAZOO RIVER SUPERFUND SITE  
APPENDIX A - GEOSTATISTICAL PILOT STUDY

**DISTRIBUTION OF SAMPLE  
PAIR DISTANCES ( < 1000 FT)**

**FIGURE  
A-3**



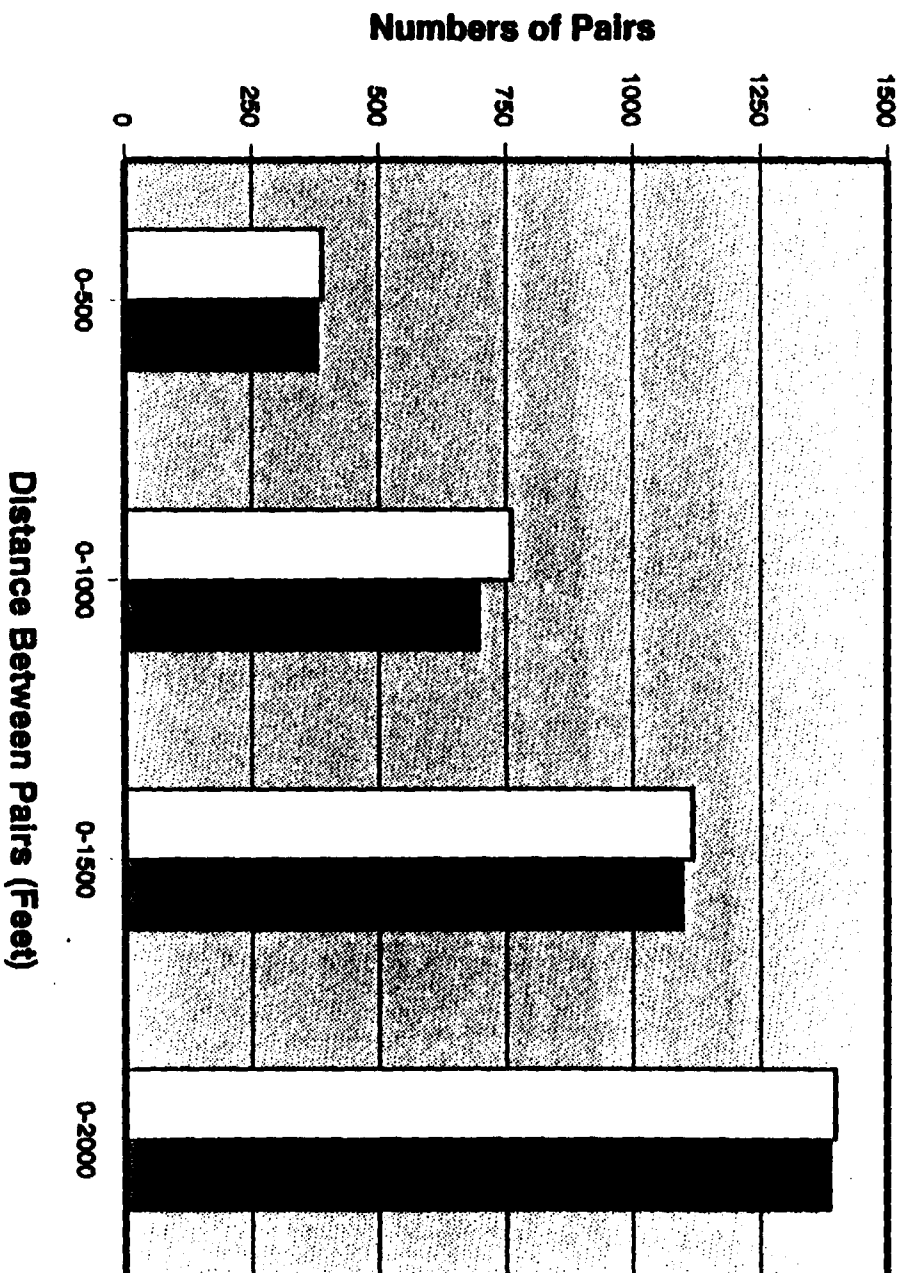
KB 511

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APPENDIX A - GEOSTATISTICAL PILOT STUDY

**DISTRIBUTION OF SAMPLE  
PAIR DISTANCES ( < 3000 FT)**

**FIGURE  
A-4**



**Legend**

□ KRSR Proposal

■ MDNR Proposal

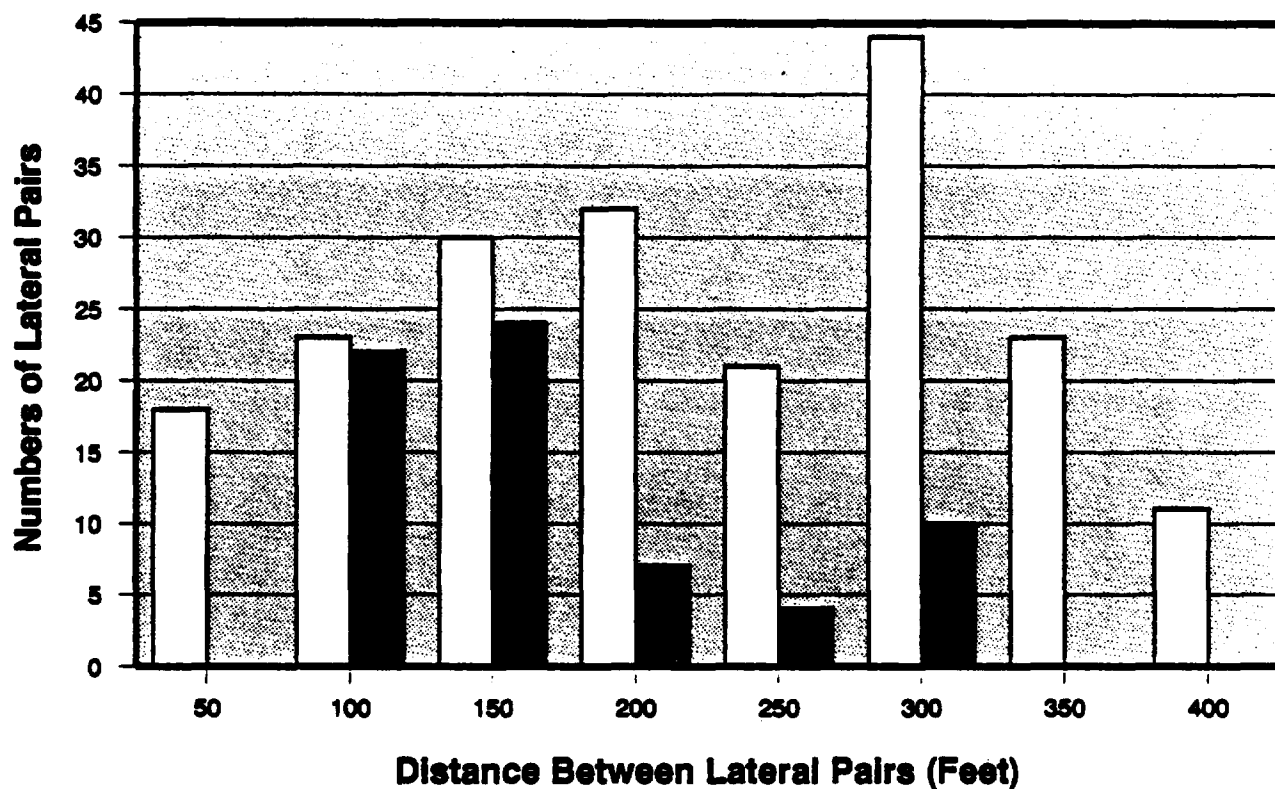
KB 511

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APPENDIX A - GEOSTATISTICAL PILOT STUDY

**COMPARISON OF KRSR AND  
MDNR SAMPLE PAIRS**

FIGURE  
**A-5**



**Legend**

- KRSR Proposal
- MDNR Proposal

02/93 DS4-DJM  
6450158RV64501n04.cdr

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APPENDIX A - GEOSTATISTICAL PILOT STUDY

COMPARISON OF KRSR AND  
MDNR LATERAL SAMPLE  
PAIRS FOR ANISOTROPY

FIGURE  
**A-6**

KB 511

## **APPENDIX B**

### **Data Requirements for PCB Fate and Transport Modeling**

**Data Requirements for PCB Fate and Transport Modeling**

Mathematical models of PCB transport have been used to assess the hypothetical response of rivers, including the Kalamazoo River, to potential sediment remediation alternatives. The endpoints of interest for the evaluation of the long-term effectiveness of remediation alternatives for sediment contaminants such as PCBs, include future contaminant concentrations in biota, water, and sediment.

At MDNR's direction the data needs for mathematical modeling of PCB transport and fate have been considered in the design of the RI tasks and are herein explicitly addressed. USEPA's Water Quality Analysis Program Version 4.3, also known as WASP4, is the most widely used numerical model for the analysis of remedial alternatives for contaminated sediment sites. WASP4 is a modeling system designed to simulate the movement of water, and the movement and interaction of both conventional and toxic pollutants within both the water column and sediments (Ambrose et al., 1988). WASP4 incorporates an independent hydrodynamics model, DYNHYD4, and two kinetic submodels, EUTRO4 and TOX14, to address eutrophication and toxic substances, respectively. WASP4 supersedes previous models developed by USEPA including WASTOX and TOXIWASP by incorporating and expanding upon their components. In-progress applications include the Hudson River and Buffalo River in New York; the Sheboygan River and Fox River in Wisconsin; and Saginaw Bay in Michigan.

WASP4 does not have a well-developed and realistic representation of sediment erosion and transport. However, the model's representation of sedimentary processes and sediment water-interactions are improved over earlier models. At most river sites where this model is being applied, separate sediment transport models are being used to analyze the dynamic processes of sediment erosion, transport, and deposition. The marriage of sediment transport models to WASP4-type water quality models is occurring at several sites.

While WASP4 or similar models appear to be the models of choice for the 1990s to analyze constituent fate and transport in rivers and harbors, there are a variety of sediment transport models being used and developed. The ability of these models to describe cohesive sediment erosion and transport is of particular interest in the analysis of fate and transport of sediment constituents. In the environment, fine-grained organic sediments, which tend to have the highest contaminant concentrations, are held to the bottom by cohesive forces in addition to gravity. The recognized importance of cohesive sediment erosion has been one of the most important motivating factors in the recent modifications to existing sediment transport models and the development of new models. Data collected during the RI should be sufficient to develop a mathematical model of PCB transport as indicated in this section.

The pharmacokinetics model, Food and Gill Exchange of Toxic Substances (FGETS) (Barber et al., 1987; Suarez et al., 1986), has been recently refined to simulate and predict the bioaccumulation of organic chemicals, such as PCBs, in fish. The model can be operated to analyze chemical bioaccumulation in fish

species that are exposed to constant or time-varying water concentrations and feed on other fish species and/or benthos. The FGETS model is capable of utilizing output generated from TOXI4 of the WASP4 system.

Three of the four models (DYNHYD4, WASP4 and TOXI4) contained in the WASP4 system and, potentially, the FGETS model have been identified as being potentially applicable to the Kalamazoo River RI/FS. The WASP4 modeling system is a set of dynamic compartment models which may be applied to contaminated aquatic systems, including the water column, suspended sediment, and underlying benthos. The time-varying processes of advection, dispersion, point and diffuse mass loading, and boundary exchange are represented in the system.

The basic principle of both the DYNHYD4 and WASP4 models (TOXI4 operates within WASP4) is the conservation of mass. The water volume and water-quality constituent masses being modeled are tracked and accounted for over time and space using a series of mass balance equations. The hydrodynamics program also conserves momentum, or energy, throughout time and space.

#### Hydrodynamic Modeling

One method of modeling river hydrodynamics would be to employ DYNHYD4 to solve one-dimensional equations describing the propagation of a long wave through a shallow water system while conserving both momentum (energy) and volume (mass). The equation of motion, based on the conservation of momentum, can predict water velocities and flow rates. The equation of

continuity, based on the conservation of volume, can predict water heights (head) and volumes.

DYNHYD4 requires four types of input parameter data; characterization of each "junction" and channel (geometric parameters); inflow/outflow conditions; downstream boundary conditions; and wind factors.

Specific parameters and data requirements for each type of input parameter for DYNHYD4 are given in Table 5-9.

#### Modeling Fate and Transport

TOXI4, a dynamic compartment submodel of the WASP4 water quality model, can be applied to characterize the fate and transport of organic chemicals and metals in various types of aquatic systems. It incorporates the hydrodynamic results of DYNHYD4 with transport capabilities of WASP4 while utilizing the sediment balance and chemical transform capabilities of its own algorithms. WASP4 traces the water quality constituent from the point of spatial and temporal input to its final point of export, conserving mass in space and time. These mass-balance data, together with the general WASP4 mass-balance equations and the chemical kinetics equations, form a unique set of equations. These are numerically integrated by WASP4 as a simulation proceeds in time.

The TOXI4 model can be operated at various levels of complexity to characterize fate and transport of PCB in river systems. These levels incorporate increased sophistication of the behavior of solids, equilibrium reactions, and kinetic reactions.

The data input requirements of TOX14 are a function of the degree of requisite complexity necessary to reasonably simulate solids behavior, equilibrium reactions, and kinetic reactions. Use of applicable first-order kinetics would require further characterization of conditions in order to simulate total solid behavior, and refine spatially variable partitioning coefficient and spatially-variable rate constants.

Four categories of input parameters are required by WASP4: initial conditions, transport factors, boundary conditions, and transformation characteristics. Specific initial conditions and input parameters include: initial time, final time, advection factor, and negative solution option. The transport input parameters (which describe the network of segments representing the water body along with the advective and dispersive flow fields connecting the segments) include: segment volumes, advective flows, sediment transport velocities, dispersion coefficients, cross-sectional areas, and characteristic lengths. The boundary input parameters include boundary concentrations and waste loads. The transformation input parameters include: spatially variable parameters, constants, and kinetic time functions for the water quality constituents being simulated (none are necessary for dissolved, conservative chemicals). These spatially variable parameters include: initial condition, dissolved fractions, solid densities, and maximum concentrations. Specific parameters and their data needs and method of acquisition are given in Table 5-9.

### Modeling Fish PCB Bioaccumulation

The FGETS model simulates thermodynamically driven chemical exchange by fish assuming either aqueous exposure only or joint aqueous and food chain exposure. Parameterization of the model incorporates allometric relationships between the fish's body weight and its gill and intestinal surface areas, lipid content of the fish, and physico-chemical properties of the chemical (i.e., molecular weight, melting point, n-octanol/water partition coefficient).

Despite the degree of parameterization in FGETS, simple empirical bioaccumulation models which relate water-column PCB concentrations to fish PCB concentrations may be a preferable alternative if they can be reliably calibrated. Reliable calibration should be afforded by the large amount of water and fish data that will be collected as part of the RI.

### Model Set-up and Calibration

Set-up of WASP4 might require the testing of Kalamazoo River sediments to assess sediment-water partition coefficients. Set-up of FGETS may require simulations based on site-specific lipid content of effected fish, fish growth rates, and fish-whole body PCB concentrations, all of which could be taken directly from the RI data set or estimated reliably from existing data.

Model calibration is the process of model testing and tuning so that the model predictions conform to a set of observations. Ideally those observations should not be used to establish the values assigned to

parameters in setting up in the model. Tuning of the model involves the adjustment of the values of model parameters until agreement between predictions and observations is achieved. Subsets of water flow, suspended solids concentration, water-column PCB concentrations and fish PCB concentrations would be the principal observations used for calibration.

It is not expected that any field or bench-scale studies which may be necessary to collect data for calibration purposes would interfere with the schedule completion of the FS report.

Table B-1

Allied Paper, Inc./Portage Creek/Kalamazoo River  
Superfund Site

RI/FS Work Plan

Input Requirements for Kalamazoo River RI/FS  
WASP Modeling System: DYNHYD4 and WASP4/TOXI4 Models

Parameters	Data Requirements <sup>1</sup>	RI Data Acquisition <sup>2</sup>
<b>DYNHYD4 Hydrodynamics Model</b>		
<b>JUNCTION AND CHANNEL PARAMETERS</b>	The input parameters associated with junctions are initial surface elevation (head), surface area, and bottom elevation. Volumes and mean depths are calculated internally. The input parameters associated with channels are length, width, hydraulic radius or depth, channel orientation, initial velocity, and Manning's roughness coefficient	This model requires data to be collected at "junctions" located in the middle of segments. Model segments will be defined by the transect locations where data will be collected during the sediment characterization investigation. Most of these data will be obtained from the sediment characterization study and from digitized maps, or estimated in the case of Manning's roughness coefficient.
Surface elevation or head	Junction heads represent the mean elevation of the water surface above or below an arbitrary horizontal datum. The datum is usually the mean local sea level. If initial surface elevations are not input, they will be calculated from bottom elevation and depth.	Surface (stage) elevation will be obtained during transect profiling as part of the sediment characterization investigation study. Additional stage elevation data will be provided from the two river gages.
Surface area	Except when branching or looping occurs (i.e., when more than two channels enter a junction), the surface area of a junction is equated to one-half of the sum of the surface areas of the two channels entering the junction. When branching or looping does occur, the junction surface areas can be determined by laying out a polygon network using the Thiessen Polygon method. Since the polygons are normally irregular, a planimeter be used to calculate surface area.	The surface area will be calculated from the digitized base maps using AutoCAD/DCA.

Table B-1  
(Cont'd)  
Allied Paper, Inc./Portage Creek/Kalamazoo River  
Superfund Site

RI/FS Work Plan

Input Requirements for Kalamazoo River RI/FS  
WASP Modeling System: DYNHYD4 and WASP4/TOXI4 Models

Parameters	Data Requirements <sup>1</sup>	RI Data Acquisition <sup>2</sup>
<b>DYNHYD4 Hydrodynamics Model</b>		
Bottom elevation	The mean elevation of the junction bottom above or below the datum is defined as the bottom elevation. If initial surface elevations are specified, bottom elevations will be calculated internally by subtracting the mean depth from the mean head.	Bottom elevations will be estimated from the transect data.
Volume	Initial junction volumes are computed internally by multiplying the junction surface area by the mean depth of the channels (weighted by their cross-sectional area) entering the junction. Junction volumes are updated throughout the simulation by adding the product of the surface area and the change in surface elevation to the initial volume.	Volumes will be computed internally by the model.
Length	The channel length is the distance between the midpoints of the two junctions it connects. Channels must be rectangular and should be oriented so as to minimize the depth variation as well as reflect the location and position of the actual prototype channels. The channel length is generally dependent on a computational stability criteria given by: $L_i \geq (\text{SQRT}(gy_i) \pm U_i) \Delta t$ where, $L_i$ = length of channel i (in m) $g$ = acceleration of gravity (9.8m/sec <sup>2</sup> ) $y_i$ = mean depth of channel i (in m) $U_i$ = velocity in channel i (in m/sec) $\Delta t$ = computational time step	Length will be measured from the base maps using AutoCAD/DCA. The intended channel length defined by distances between transects were found to be satisfactory based on the computational stability criteria formula.

Table B-1  
(Cont'd)  
Allied Paper, Inc./Portage Creek/Kalamazoo River  
Superfund Site

RI/FS Work Plan

Input Requirements for Kalamazoo River RI/FS  
WASP Modeling System: DYNHYD4 and WASP4/TOXI4 Models

Parameters	Data Requirements <sup>1</sup>	RI Data Acquisition <sup>2</sup>
<b>DYNHYD4 Hydrodynamics Model</b>		
Width	There is no apparent limit on the width of a channel. If a channel is too wide in relation to its length, however, the mean velocity predicted may mask important velocity patterns occurring on a more local scale. For well-defined channels, the network channel widths are equated to the average bank to bank width.	Width measurements will be obtained during transect activities.
Cross-sectional area	The cross-sectional area of a channel is equal to the product of the channel width and depth. Depth, however, is a channel parameter that must be defined with respect to junction head or water surface elevation (since both vary similarly with time). Initial cross-sectional areas are computed internally. As the junction heads vary, the channel cross-sectional areas are adjusted accordingly.	Cross-sectional area will be computed internally. Initial lead, width, and depth at each junction will be collected during the transect activities.
Roughness coefficients	Channels are assigned "typical" Manning's roughness coefficients. The value of this coefficient should usually lie between 0.01 and 0.08. Because this parameter cannot be measured, it serves as a "knob" for the calibration of the model.	This parameter cannot be measured, and hence, will be estimated from literature values after field reconnaissance.
Velocity	An initial estimate of the mean channel velocity is required. Although any value may be assigned, the computational time required for convergence to an accurate solution will depend on how close the initial estimate is to the true value. Convergence is usually rather quick.	Velocity measurements will be made during the transect study and will also be estimated during the water sampling program.

Table B-1  
(Cont'd)  
Allied Paper, Inc./Portage Creek/Kalamazoo River  
Superfund Site

RI/FS Work Plan

Input Requirements for Kalamazoo River RI/FS  
WASP Modeling System: DYNHYD4 and WASP4/TOX14 Models

Parameters	Data Requirements <sup>1</sup>	RI Data Acquisition <sup>2</sup>
<b>DYNHYD4 Hydrodynamics Model</b>		
Hydraulic radius	Previous applications of DYNHYD have used channels whose widths are greater than ten times the channel depth. Consequently, the hydraulic radius is usually assumed to be equal to the mean channel depth.	The mean channel depth will be calculated from the transect data.
Channel orientation	The channel orientation is the direction of the channel axis measured to higher junction number, which is by convention the direction of positive flow.	Channel orientation will be obtained from the base maps using AutoCAD/DCA.
<b>INFLOW/OUTFLOW PARAMETERS</b>	Inflows can be specified as constant or time variable. Inflows are represented by negative flows; outflows are represented by positive flows. For each time-variable inflow, a piecewise linear function of flow versus time will be specified. If the simulation extends beyond the last specified flow, the flow assumes a constant inflow equal to the last specified flow.	The inflow/outflow parameters will be held constant for preliminary modeling purposes. Time variable data may be utilized to characterize storm event or seasonal discharges.
<b>DOWNSTREAM BOUNDARY PARAMETERS</b>	The downstream boundaries can be defined by either specifying outflows or surface elevations. Outflows are handled as negative inflows.	Downstream boundary conditions are controlled by elevations of the dams and Lake Michigan.
<b>WIND PARAMETERS</b>	The input parameters with wind acceleration are wind speed, wind direction, channel orientation, and channel hydraulic radius. The last two were discussed as channel parameters. Wind speed and direction are measured at a point 10 meters above the water surface. This wind is to be representative for the entire water body. Values of wind speed and direction versus time are specified. If the simulation extends beyond the last specified wind, the piecewise linear functions are repeated.	A wind rose simulation based on data from the local meteorological station will be applied to the model.

Table B-1  
(Cont'd)  
Allied Paper, Inc./Portage Creek/Kalamazoo River  
Superfund Site

RI/FS Work Plan

Input Requirements for Kalamazoo River RI/FS  
WASP Modeling System: DYNHYD4 and WASP4/TOXI4 Models

Parameters	Data Requirements <sup>1</sup>	RI Data Acquisition <sup>2</sup>
<b>WASP4/TOXI4 Water Quality/Toxics Model</b>		
<b>MODEL IDENTIFICATION AND CONTROL PARAMETERS</b>	These parameters give the basic model identity. They include the number of water quality constituents being simulated and the number of segments in the network. Also included are titles describing the water body and the simulation. This group of parameters control the simulation and checks the stability of the solution. Simulation parameters include the initial and final times, integration time steps, the advection factor, maximum concentrations, and a negative solution option.	
Initial Time (days)	The time at the beginning of the simulation must be specified in order to synchronize all the time functions. The day, hour, and minute can be input.	These parameters will be defined as needed.
Final Time (days)	The time at the end of the simulation must be specified in days (including decimal fraction).  Integration time step (days). A sequence of integration time steps (delta t) must be specified, along with time interval over which they apply. Given specific network and transport parameters, time steps are constrained within a specific range to maintain stability and minimize numerical dispersion, or solution inaccuracies. To maintain stability at a segment, the advected, dispersed, and transformed mass must be less than the resident mass.	These parameters will be defined as needed.

Table B-1  
(Cont'd)  
Allied Paper, Inc./Portage Creek/Kalamazoo River  
Superfund Site

RI/FS Work Plan

Input Requirements for Kalamazoo River RI/FS  
WASP Modeling System: DYNHYD4 and WASP4/TOX14 Models

Parameters	Data Requirements <sup>1</sup>	RI Data Acquisition <sup>2</sup>
<b>WASP4/TOX14 Water Quality/Toxics Model</b>		
Advection Factor (dimensionless)	The advection factor, $v$ , can be specified to modify the finite difference approximation of $dc/dx$ used in the advection term by WASP. For $v=0$ , the backward difference approximation is used. This is most stable, and is recommended for most applications.	To be estimated from literature values.
Negative Solution Option	Normally, concentrations are not allowed to become negative. If a predicted concentration at $t+\Delta t$ is negative, WASP maintains its positive values by instead halving the concentrations at time $t$ . The negative solution option lets the user bypass this procedure, allowing negative concentrations. This may be desirable for simulating dissolved oxygen deficit in the benthos, for example.	This parameter will be defined as needed.
TRANSPORT PARAMETERS	This broad group of parameters describes the network of segments representing the water body along with the advective and dispersive flow fields connecting the segments. Input parameters include segment volumes, advective flows, sediment transport velocities, dispersion coefficients, cross-sectional areas, and characteristic lengths. Although the nominal units expected by the model are SI, English or other units can be used along with proper specification of the conversion factors.	

Table B-1  
(Cont'd)  
Allied Paper, Inc./Portage Creek/Kalamazoo River  
Superfund Site

RI/FS Work Plan

Input Requirements for Kalamazoo River RI/FS  
WASP Modeling System: DYNHYD4 and WASP4/TOXI4 Models

Parameters	Data Requirements <sup>1</sup>	RI Data Acquisition <sup>2</sup>
<b>WASP4/TOXI4 Water Quality/Toxics Model</b>		
Segment Volume	Initial volumes for each segment can be calculated from navigation charts or a series of transects measuring depth versus width along the river. Sometimes, volumes can be estimated from travel time of a well-mixed cloud of dye through a reach. Initial segment volumes can be automatically adjusted for continuity during a simulation by specifying IVOPT=2. For simulations using hydrodynamics results from DYNHYD4, volumes from the SUMRY2 file are used and continuity is maintained.	To be estimated from transect data.
Advective flow	Steady or unsteady flows can be specified between adjoining segments, as well as entering or leaving the network as inflow or outflow. The user must be careful to check for continuity errors, as the model does not necessarily require that flow continuity be maintained. For example, the user may specify that more flow enters a segment than leaves. If IVOPT=2, continuity will be maintained and that segment will grow in volume indefinitely. If IVOPT=1, however the volume will remain constant and pollutant mass will build up in the segment indefinitely. For simulations using hydrodynamic results from DYNHYD4, flows from the SUMRY2 file are used and flow continuity is automatically maintained.	This parameter will be defined based on the objective of the modeling event.

Table B-1  
(Cont'd)  
Allied Paper, Inc./Portage Creek/Kalamazoo River  
Superfund Site

RI/FS Work Plan

Input Requirements for Kalamazoo River RI/FS  
WASP Modeling System: DYNHYD4 and WASP4/TOX14 Models

Parameters	Data Requirements <sup>1</sup>	RI Data Acquisition <sup>2</sup>
<b>WASP4/TOX14 Water Quality/Toxics Model</b>		
Sediment transport velocities	Settling, deposition, scour, and sedimentation velocities can be specified for each type of solid. These velocities are multiplied by cross-sectional areas and treated as flows that carry sediment and sorbed chemical between segments. Settling velocities are important components of suspended sediment transport in the water column. Scour and deposition velocities determine the transfer of sediment and pollutants between the water column and the sediment bed. Sedimentation velocities represent the rate at which the bed is rising in response to net deposition.	To be estimated from literature values.
Dispersion coefficient	Dispersive mixing coefficients can be specified between adjoining segments, or across open water boundaries. These coefficients can model pore water diffusion in benthic samples, vertical diffusion in lakes, and lateral and longitudinal dispersion in large water bodies. Values can range from $10^{-10}$ m <sup>2</sup> /sec for molecular diffusion to $5 \times 10$ m <sup>2</sup> /sec for longitudinal mixing in some estuaries.	To be estimated from stream characteristics. If needed, a dye study will be conducted.
Cross-sectional area	Cross-sectional areas are specified for each dispersion coefficient, reflecting the area through which mixing occurs. These can be surface areas of vertical exchange, such as in lakes or in the benthos. Areas are not modified during the simulation to reflect flow changes.	To be estimated.

Table B-1  
(Cont'd)  
Allied Paper, Inc./Portage Creek/Kalamazoo River  
Superfund Site

RI/FS Work Plan

Input Requirements for Kalamazoo River RI/FS  
WASP Modeling System: DYNHYD4 and WASP4/TOXI4 Models

Parameters	Data Requirements <sup>1</sup>	RI Data Acquisition <sup>2</sup>
<b>WASP4/TOXI4 Water Quality Model</b>		
Characteristic mixing length	Mixing lengths are specified for each dispersion coefficient, reflecting the characteristic length over which mixing occurs. These are typically the lengths between the center points of adjoining segments. A single segment may have three or more mixing lengths for segments adjoining longitudinally, laterally, and vertically. For surficial benthic segments connecting water column segments, the depth of the benthic layer is more realistic mixing length than half the water depth.	To be estimated.
<b>BOUNDARY PARAMETERS</b>	This group of parameters includes boundary concentrations and waste loads.	
Boundary concentration	Steady or time-variable concentrations must be specified for each water quality constituent at each boundary. A boundary is either a tributary inflow, a downstream outflow, or an open water end of the model network across which dispersive mixing can occur. Advective and dispersive flows across boundaries are specified by the transport parameters.	Concentration data will be collected from the surface water investigation.
Waste load	Steady or time-variable loads may be specified for each water quality constituent at several segments. These loads represent municipal and industrial wastewater discharges, urban and agricultural runoff, precipitation, and atmospheric deposition of pollutants.	To be estimated from NPDES records.
<b>TRANSFORMATION PARAMETERS</b>	This group of parameters includes spatially variable parameters, constants, and kinetic time functions for the water quality constituents being simulated. None are necessary for dissolved, conservative chemicals.	For PCBs, decay or transformation will not be characterized.

Table B-1  
(Cont'd)  
Allied Paper, Inc./Portage Creek/Kalamazoo River  
Superfund Site

RI/FS Work Plan

Input Requirements for Kalamazoo River RI/FS  
WASP Modeling System: DYNHYD4 and WASP4/TOX14 Models

Parameters	Data Requirements <sup>1</sup>	RI Data Acquisition <sup>2</sup>
<b>WASP4/TOX14 Water Quality/Toxics Model</b>		
<b>INITIAL CONDITIONS</b>	This category initial concentrations, dissolved fractions, and densities.	
Initial concentration	Concentrations of each constituent in each segment must be specified for the time at which the simulation begins. For those water bodies with low transport rates, the initial concentrations of conservative substances may persist for a long period of time. Accurate simulation, then, would require accurate specification of initial concentrations. If initial concentrations cannot be determined accurately, then longer simulations should be run, and early predictions discounted.	Concentrations will be obtained during the surface water investigation.
Dissolved fractions	The initial fraction of chemical dissolved in the water portion of a segment is input as a fraction of total chemical concentration. The dissolved fraction is important in determining the amount of chemical transported by pore water flow and dispersion, and by solids transport. Dissolved fractions may be computed from sorption kinetics in the transformation subroutines.	Dissolved fractions will be computed from sorption. Kinetics will be computed in the transformation subroutine of the model.
Solid densities	The density of each type of solid is needed to compute the porosity of bed segments. Porosity will be a function of sediment concentration and density of each solid type.	Density will be estimated for literature values.
Maximum concentrations	Maximum concentrations must be specified for each water quality constituent. The simulation is automatically aborted if a calculated concentration falls outside these limits. This usually indicates computational instability, and the time step must usually be reduced.	Maximum concentrations will be obtained during the surface water investigations.

Table B-1  
(Cont'd)  
Allied Paper, Inc./Portage Creek/Kalamazoo River  
Superfund Site

RI/FS Work Plan

Input Requirements for Kalamazoo River RI/FS  
WASP Modeling System: DYNHYD4 and WASP4/TOXI4 Models

Notes:

- <sup>1</sup> Parameter data requirements from Ambrose, R.B., et al., 1988.
- <sup>2</sup> This column summarizes the means by which the model parameter data will be acquired or estimated.

## **APPENDIX C**

### **Assessment Of PCB Congener Distribution Using The Modified USEPA SW-846 Method 8081**

Assessment of PCB Congener Distribution Using the Modified USEPA  
SW-846 Method 8081

PCB congeners present in samples analyzed with the Modified USEPA SW-846 Method 8081 used by Aquatec Inc. (Aquatec) can be identified based on the analysis of commercial Aroclors by Schulz et al. (1989). Schulz et al. (1989) used multidimensional gas chromatograph (GC) - electron capture detector (ECD) analysis to completely characterize the congeners present in commercial Aroclors 1016, 1242, 1254, 1260. From the multidimensional GC-ECD analysis, Schulz et al. (1989) identified peaks which represent single or groups of two to three co-eluting congeners on ECD chromatograms of Aroclors 1016, 1242, 1254, and 1260 from a single SE-54 column (50 meter). Of the 87 identified peaks from the commercial Aroclor chromatograms, 56 peaks represented individual congeners and the remaining 31 peaks comprised two or three co-eluting congeners. Figures 1 and 2 illustrate the peaks identified by Schulz et al. (1989) using the 50-meter SE-54 column for Aroclors 1242 and 1260.

The chromatograms generated from Aquatec's Modified USEPA SW-846 Method 8081 are from a RTX-5 column (30 meter). The RTX-5 column is analogous to the SE-54 column in packing material: 5% diphenyl-95% dimethyl polysiloxane. Therefore the RTX-5 column is expected to generate a chromatogram pattern nearly identical to the SE-54 chromatogram for comparable chromatograph conditions. Aroclor 1242 and combined Aroclor 1016 and 1260

standard chromatograms generated from Aquatec's RTX-5 column are shown in Figures 3 and 4, respectively. Comparing the SE-54 and the RTX-5 chromatograms, correspondence of the chromatographic patterns of peaks generated from the SE-54 column and Aquatec's RTX-5 can be readily seen (See numbered peaks for SE-54 and RTX-5 chromatograms). Because of the similarity of the RTX-5 and the SE-54 chromatograms, congener identifications can be made by comparing the two chromatograms, identifying like peaks, and then relating the like peaks to specific congeners with the peak/congener identifications derived from multidimensional GC-ECD analysis. Congener assignments for the RTX-5 column are provided in Table 1.

Sample congener concentrations would be estimated using the mass analysis of Aroclors reported by Schulz et al. (1989) and the sample and standard ECD responses provided by Aquatec for the RTX-5 column.

#### Aquatec's Chromatogram Digital Format

The digital format of the chromatographic data Aquatec will provide to Blasland & Bouck consists of seven fields: peak group, retention time (min.), retention time expected (min.), peak height (uV), peak area (uVs), peak width (sec.), and parts per billion concentration of peak (Table 1). The most important field which will be used in congener identification is the retention time

field. The digital format will allow for easy scanning and congener identification of sample chromatograms via a microcomputer.

Reference

Schulz, D.E., G. Petrick, and Jan C. Duinker, "Complete Characterization of Polychlorinated Biphenyl Congeners in Commercial Aroclor and Clophen Mixtures by Multidimensional Gas Chromatography-Electron Capture Detection," Environmental Science & Technology, Vol. 23, (1989), pp 852-859.

Table C-1

Allied Paper, Inc./Portage Creek/Kalamazoo River  
Superfund Site

PCB Congener Identification of Aroclors 1242 and 1260  
from Aquatec's RTX-5 Column

Peak Number	IUPAC Number	
	Aroclor 1242	Aroclor 1016/1260 <sup>2</sup>
4	8 5'	-- --
5	19	--
6	18 17 15	-- -- --
7	24 27	-- --
8	16 32	-- --
11	26	--
12	25	--
13	31 28	-- --
14	20' 30 53	-- -- --
15	51' 22	-- --
16	45	--
17	46	--
19	52	--
20	49	--

**Table C-1**

**Allied Paper, Inc./Portage Creek/Kalamazoo River  
Superfund Site**

**PCB Congener Identification of Aroclors 1242 and 1260  
from Aquatec's RTX-5 Column**

Peak Number	IUPAC Number	
	Aroclor 1242	Aroclor 1016/1260 <sup>2</sup>
21	47 48 75 <sup>1</sup>	-- -- --
23	44	--
24	37 59 42	-- -- --
25	41 64	-- --
27	40	--
30	74	--
31	70	--
32	66 95	-- --
34	91	--
35	60 56	-- --
38	90 101	-- --
39	99	--
42	97	--
43	87 115 <sup>1</sup>	-- --
44	85	--
45	--	136

**Table C-1**

**Allied Paper, Inc./Portage Creek/Kalamazoo River  
Superfund Site**

**PCB Congener Identification of Aroclors 1242 and 1260  
from Aquatec's RTX-5 Column**

Peak Number	IUPAC Number	
	Aroclor 1242	Aroclor 1016/1260 <sup>2</sup>
46	77 110	77' 110
47	82 151 <sup>1</sup>	82' 151
48	--	135
50	123 <sup>1</sup> 149 118	123' 149 118 <sup>1</sup>
53	--	146
54	132 153 105	132 153 105 <sup>1</sup>
55	--	141 179
57	--	176 137 <sup>1</sup>
58	160 <sup>1</sup> 138 158 <sup>1</sup>	160 138 158
59	--	129 126 <sup>1</sup> 178
61	--	187
62	--	183
63	--	128
65	--	185

**Table C-1**

**Allied Paper, Inc./Portage Creek/Kalamazoo River  
Superfund Site**

**PCB Congener Identification of Aroclors 1242 and 1260  
from Aquatec's RTX-5 Column**

Peak Number	IUPAC Number	
	Aroclor 1242	Aroclor 1016/1260 <sup>2</sup>
66	--	174
67	--	177
68	--	202 171 156
69	--	173 157 201
70	--	172
72	--	180
75	--	200
77	--	170 190
79	--	199
80	--	203 196
82	--	208 195
84	--	194
86	--	205

**Note:**

- <sup>1</sup> Represents less than 5 percent of the total mass of the co-eluting congeners.
- <sup>2</sup> Represents only Aroclor 1260 portion of chromatogram.

**Table C-1**

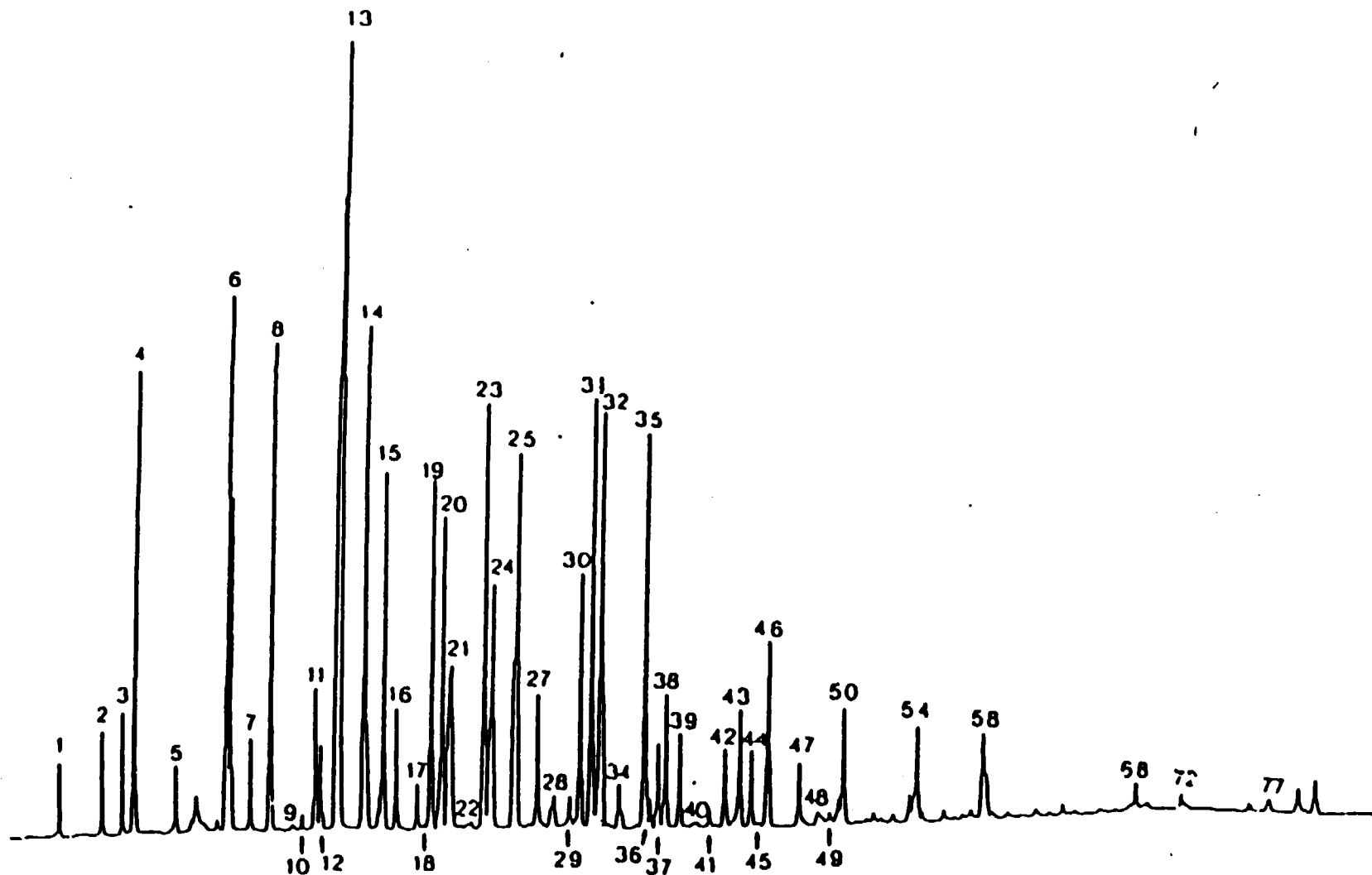
**Allied Paper, Inc./Portage Creek/Kalamazoo River  
Superfund Site**

**PCB Congener Identification of Aroclors 1242 and 1260  
from Aquatec's RTX-5 Column**

Peak Number	IUPAC Number	
	Aroclor 1242	Aroclor 1016/1260 <sup>2</sup>
66	--	174
67	--	177
68	--	202 171 156
69	--	173 157 201
70	--	172
72	--	180
75	--	200
77	--	170 190
79	--	199
80	--	203 196
82	--	208 195
84	--	194
86	--	205

**Note:**

- <sup>1</sup> Represents less than 5 percent of the total mass of the co-eluting congeners.
- <sup>2</sup> Represents only Aroclor 1260 portion of chromatogram.



REFERENCE: SCHULZ ET AL., (1989)



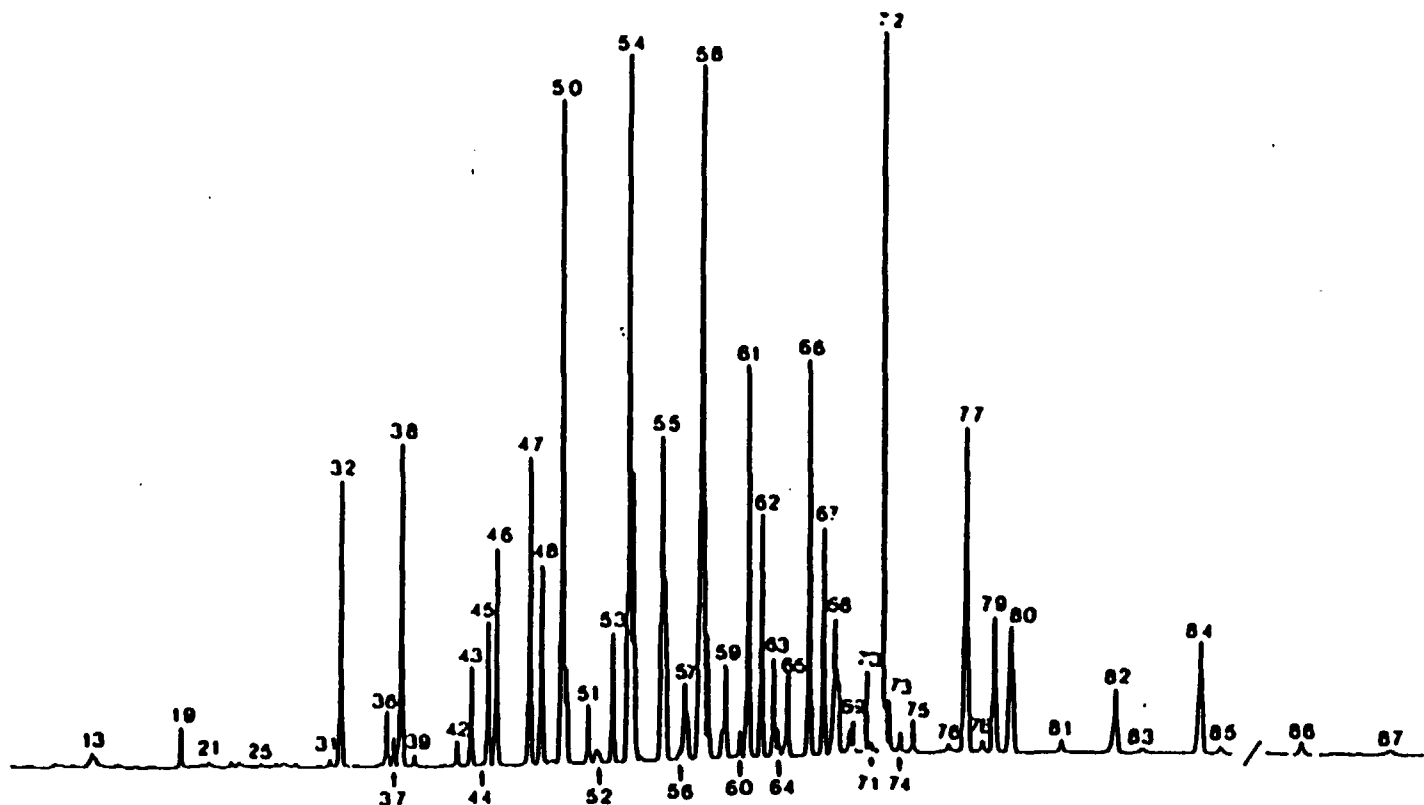
BLASLAND & BOUCK ENGINEERS, P.C.  
ENGINEERS & SCIENTISTS

KALAMAZOO RIVER STUDY GROUP  
ALLIED PAPER INC. / PORTAGE CREEK  
KALAMAZOO RIVER SUPERFUND SITE

AROCLOR 1242  
ANALYZED BY  
SE-54 COLUMN

FIGURE

1



REFERENCE: SCHULZ ET AL., (1989)



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ENGINEERS & SCIENTISTS

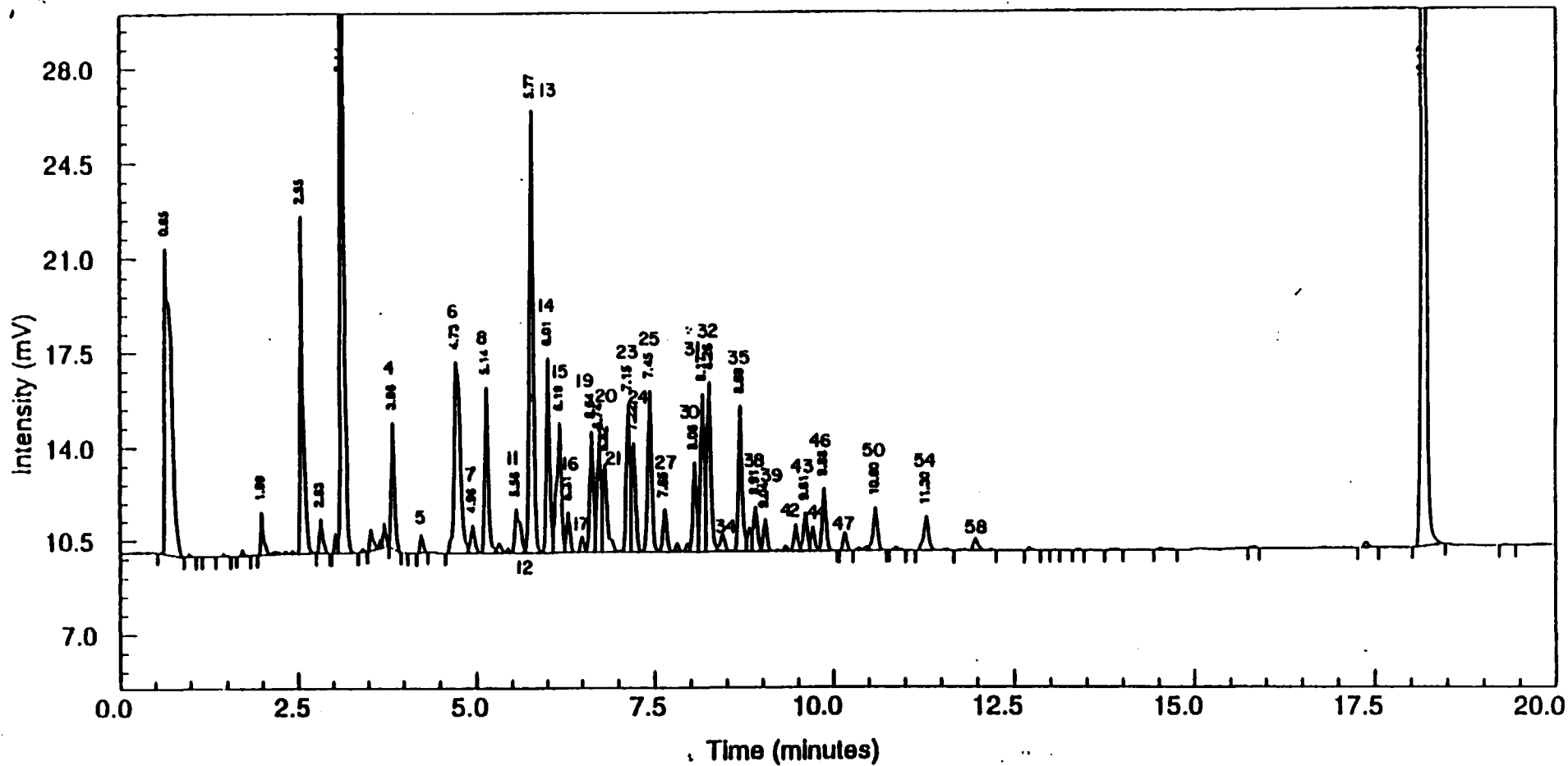
KALAMAZOO RIVER STUDY GROUP  
ALLIED PAPER INC./PORTAGE CREEK  
KALAMAZOO RIVER SUPERFUND SITE

**AROCLOR 1260**  
**ANALYZED BY**  
**SE-54 COLUMN**

FIGURE  
2

JUNE 1993  
848.24.37

KB 511



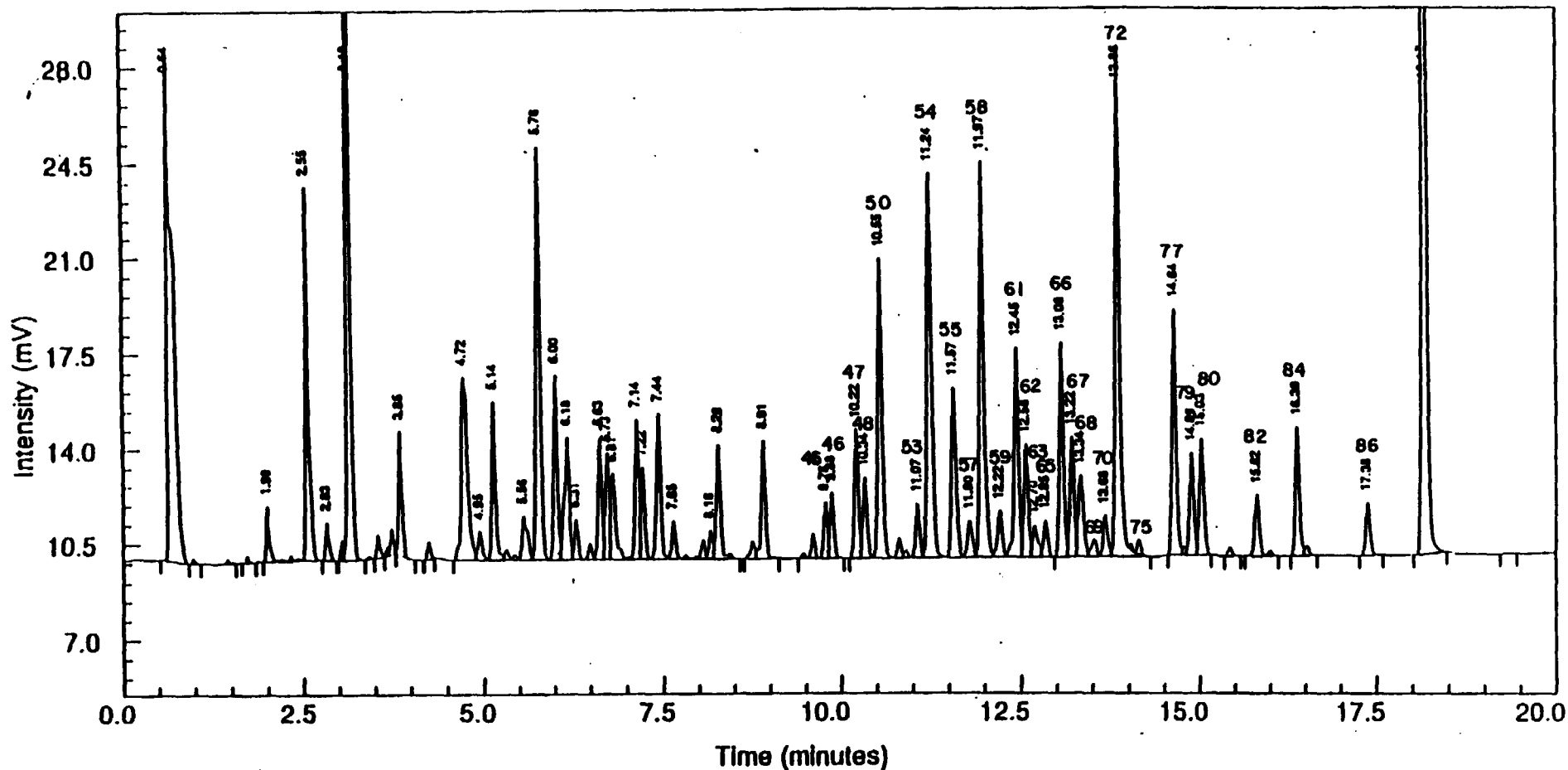
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KALAMAZOO RIVER SUPERFUND SITE

**AROCLOR 1242  
ANALYZED BY  
RTX-5 COLUMN**

FIGURE  
**3**

KB 511



REFERENCE: AQUATEC INC. 1993

JUNE 1993  
648.24.37

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KALAMAZOO RIVER STUDY GROUP  
ALLIED PAPER INC./PORTAGE CREEK  
KALAMAZOO RIVER SUPERFUND SITE

AROCLOR 1016 AND 1260  
ANALYZED BY  
RTX-5 COLUMN

FIGURE

4

KB 511

**APPENDIX D**  
**Plan For The Use Of Immunoassay**  
**Field Screening Kits**

Blasland & Bouck proposes to use PCB immunoassay test kits for selected tasks within the Kalamazoo River Site Work Plan (including OU's). The field analysis will be used for soil/sediment screening on an as needed basis, particularly for defining the extent of PCBs present. Standard concentrations for the soil screening will be 1 mg/kg and 20 mg/kg.

The assays typically include two components: Sample extraction and analysis. The sample extraction component integrates collection, extraction and filtration to produce a particle-free sample. The filtered sample is analyzed using a coated-tube immunoassay that contains anti-PCBs antibody and PCB enzyme conjugate reagents. This system requires few analytical steps and is therefore, relatively easy to perform in the field. The intensity of the color at the endpoint of the test is inversely proportional to the concentration of the PCBs. Interpretation is performed by comparing the color produced by a sample to that of the kit standards. The specific methodology for use of the immunoassay field kits has been included in Attachment D-1.

Specific tasks which will involve the use of immunoassay kits are identified in the following:

1. To delineate the lateral and vertical distribution of PCBs in Exposed Former Impoundment Sediment.

Six transects within each of the former Plainwell and Otsego Impoundments, and nine transects within the former Trowbridge Impoundment will be established. The outward lateral extent of the

former impoundment transects will be established in the field on the basis of a set of three alternative criteria. The first criterion will be an extension of the transect until sediment/soil PCB concentrations are below detection [ $< 1$  (mg/kg)] using immunoassay PCB-Testing procedures.

Along each transect at the initially established outer boundary of the estimated extent of sediments containing PCBs, a core sample will be taken to extend through the native soil. Samples from the 0- to 6-inch interval and each subsequent 1-foot interval to depth of refusal will be screened using the immunoassay field kit with a standard PCB concentration of 1 mg/kg. If any sample is less than 1 mg/kg the sediment sampling will continue towards the river using the field screening method until samples are greater than 1 mg/kg. Subsequent samples along each transect will be analyzed using traditional lab techniques (Method 8080).

2. To determine the extent of PCBs in Kalamazoo River and Portage Creek Floodplain Soils.

A total of five transects will be established between the confluence with Portage Creek and the City of Allegan. The transects extending to the approximate limit of the 100-year floodplain are presented in Figures 4, 6, 7, and 8 of the River Superfund Site Work Plan. (June 1993a) The upstream-most transect will be located in

Verburg Park, just south of Paterson Street in Kalamazoo. The next transect will be placed south of D Avenue on land owned by Cooper Township. These two transects will extend outward on the west bank due to the fact that the east bank is privately owned. The third transect is similar since only the south side of the Kalamazoo River is publicly owned. This transect will be placed in Brookside Park, Otsego. The fourth transect will be an extension of an impoundment transect located in the former Otsego Dam Impoundment on DNR-owned land. The final transect will be located downstream of Trowbridge Dam. The specific location will be defined when land ownership is determined and access is granted. (June 1993a)

At each transect, samples will be collected from approximately eight locations within the floodplain characterized by a flood recurrence interval of approximately 100 years. Samples taken near the boundary of the estimated 100-year floodplain will be screened by immunoassay PCB testing procedures. If the 100-year floodplain boundary sample has detectable PCB ( $>1$  mg/kg), the transect will be extended until the soil PCB concentration is less than detection ( $<1$  mg/kg). If the initial boundary sample is below detection, sampling will proceed along the transect toward the Kalamazoo River.

**ATTACHMENT D-1 (To Appendix D)**  
**Immunoassay PCB-Testing Procedures**

**FIELD SCREENING FOR PCBs USING EnSys CORP.**

**PCB RISC™ IMMUNOASSAY**

**I. Application**

Field screening is used to provide real-time analytical data to make field decisions for remedial activities. These techniques are particularly useful for defining the extent of site contamination and for the identification of hotspots and clean areas. Field screening can also be used to pre-screen samples before they are sent for analysis to reduce laboratory sample load.

**II. Summary of Method**

Immunoassays are immunochemical detection methods based on the specific binding properties of an antibody for a target analyte. Quantitation is performed based on color changes which occur in the presence of PCBs. The degree of color change is inversely proportional to the amount of PCBs present in the sample.

**III. Materials**

The materials required for use of an immunoassay field screening device include:

- Personal protective equipment, including disposable latex gloves (as specified in the Health and Safety Plan);
- Cleaning equipment;
- Test kit purchased from the manufacturer with the expiration date checked before use;
- Spectrophotometer and batteries;

- Mechanical pipette;
- Replacement pipette tips;
- Balance - capable of weighing to 0.1g;
- Permanent marker;
- Laboratory tissue/absorbent paper;
- Timer or stopwatch;
- Aluminum tray; and
- Stainless steel spatula.

#### **IV. Procedures**

A detailed procedure for using EnSys Corporation's PCB RISc™ kit is as follows:

##### **A. Sample Preparation**

1. Don appropriate personal protective equipment (as required by the Health and Safety Plan).
2. Composite a previously collected soil/sediment/residual sample using the stainless steel spatula on the aluminum tray and allow to air dry.
3. Weigh out  $10 \pm 0.1$  grams of composited soil/sediment/residuals using the weight boat provided in the test kit.
4. Transfer the sample to the extraction jar, recap the jar, shake vigorously for one minute, and then let settle for one minute.
5. Remove lid from extraction jar, disassemble filtration plunger from filtration barrel, insert bulb pipette into liquid in extraction jar and draw up sample; and

6. Transfer at least half the bulb capacity into filtration barrel, press plunger firmly into the barrel until at least 1/2 millileter (ml) of filtered sample is available.

**B. Dilution & Buffering of Samples & Standards**

1. Using a permanent marker write "Standard 1", "Standard 2", and "1 ppm" near the top of a buffer tube and an antibody coated tube, place these tubes in the workstation.
2. Inset a new tip onto the mechanical pipette.
3. Withdraw 30 microliters (uL) of filtered sample using the mechanical pipette and dispense below the liquid level in the 1 ppm dilution vial, withdraw another 30 uL of the filtered sample and add to the vial the same way, replace the cap on the vial and gently shake for 5 seconds.
4. Withdraw 30 uL of diluted sample from the 1 ppm dilution vial and dispense below the liquid level in the 1 ppm blue buffer tube, gently shake the uncovered buffer tube for 5 seconds.
5. Replace the tip on the mechanical pipette.
6. Withdraw 30 uL from the PCB standard vial and dispense below the liquid level in the Standard 1 blue buffer tube, wipe pipette tip with laboratory tissue.
7. Withdraw 30 uL of PCB standard and dispense below the liquid level in the Standard 2 blue buffer tube, gently shake both blue buffer tubes for 5 seconds; and
8. Immediately replace cap on the PCB standard, and dispense the mechanical pipette tip.

C. Immunoassay

1. Start timing and immediately pour the solution from each standard blue buffer tube into the appropriate standard antibody covered tube, and pour the solution from the 1 ppm blue buffer tube into the 1 ppm antibody covered tube, gently shake the three tubes for 5 seconds, and let all three stand for exactly 10 minutes.
2. Crush glass ampule contained within the enzyme dropper by pressing dropper against a hard edge (prepare 1 enzyme dropper for every 5 antibody coated tubes), mix enzyme by turning dropper end-over-end 5 times, remove seal from dropper.
3. Discard the first drop from enzyme dropper, at exactly 10 minutes (step 15), start timing and immediately dispense 3 drops into each antibody coated tube by squeezing the dropper, when all tubes have had enzyme solution added, shake antibody covered tubes for 5 seconds, let tubes stand exactly 5 minutes.
4. After the time has elapsed, discard solution from the antibody coated tubes, keep nozzle of wash solution bottle just above the top of the tube and forcefully squeeze wash solution into each tube with a strong stream to fill each tube, discard wash solution, repeat 3 times, and then tap tubes upside down on a laboratory tissue; and
5. Add 5 drops of Substrate A to the bottom of each antibody covered tube, start timing, add 5 drops of Substrate B to the bottom of each antibody covered tube, shake all antibody covered tubes for 3 to 5 seconds, let stand for exactly 2.5 minutes, and then add 5 drops of Stop Solution.

**D. Interpretation of Test Results**

1. Wipe the outside of the Standard 1 and Standard 2 antibody coated tubes with laboratory tissue and place in the photometer.
2. If photometer readout is negative or zero, discard the tube from the right well, if the photometer reading is positive, discard the tube from the left well and transfer the tube in the right well to the left well.
3. Wipe the outside of the 1 ppm antibody coated tube with laboratory tissue and place in the right well of the photometer; and
4. If the photometer reading is negative or zero, PCBs are present in the sample, if the photometer reading is positive, the concentration of PCBs is less than 1 ppm.

## FIELD SCREENING OF PCBs USING MILLIPORE EnviroGard™ IMMUNOASSAY

### I. Application

Field screening is used to provide real-time analytical data to make field decisions for remedial activities. These techniques are particularly useful for defining the extent of site contamination and for the identification of hotspots and clean areas. Field screening can also be used to pre-screen samples before they are sent for analysis to reduce laboratory sample load.

### II. Summary of Method

Immunoassays are immunochemical detection methods based on the specific binding properties of an antibody for a target analyte. Quantitation is performed based on color changes which occur in the presence of PCBs. The degree of color change is inversely proportional to the amount of PCBs present in the sample.

### III. Materials

The materials required for use of an immunoassay field screening device include:

- Personal protective equipment, (as specified in the Health and Safety Plan);
- Cleaning equipment;
- Test kit purchased from the manufacturer with the expiration date checked before use;

- Spectrophotometer and batteries;
- Mechanical pipette;
- Replacement pipette tips;
- Balance capable of weighing to 0.1g;
- Permanent marker;
- Laboratory tissue/absorbent paper;
- Timer or stopwatch;
- Distilled/deionized water;
- Soil extraction kit;
- Methanol;
- Aluminum tray; and
- Stainless steel spatula.

#### **IV. Procedures**

A detailed procedure for using Millipore Corporation's EnviroGard™ kit is as follows:

##### **A. Sample Preparation**

1. Don appropriate personal protective equipment (as required by the Health and Safety Plan).
2. Composite a previously collected soil/sediment/residual sample using the stainless steel spatula on the aluminum tray and allow to air dry.
3. Label the test tubes as follows using permanent marker: NC (negative control), 5 ppm, 10 ppm, 50 ppm, and sample (more than one tube may be labelled as sample).

4. Weigh out  $5 \pm 0.1$  g of composited soil/sediment/residuals using the weight boat provided in the extraction kit.
5. Add soil and 5 ml of methanol to the solvent extraction bottle, cap and shake vigorously for 2 minutes.
6. Insert a prefilter unit into the filter end of the plunger unit.
7. Pour the soil/methanol mixture into the filter base unit (if the soil is clay-like and absorbs the methanol, add another 5 ml of methanol and shake for another 2 minutes; do not forget to compensate for the additional dilution); and
8. Insert plunger unit into the filter base unit, press down firmly on the plunger, wait 30 to 60 seconds, press plunger down again, add 5 uL of sample extract to a corresponding test tube, repeat steps 4 to 8 for each sample to be tested.

**B. Immunoassay**

1. Using the positive displacement pipettor, add 5 uL of methanol to the NC test tube, add 5 uL of calibrator solution to the corresponding test tube.
2. Position the repeater pipettor at setting 2 and use the 12.5 mL syringe to add 500 uL of assay diluent to all test tubes, shake the test tube rack to mix.
3. Wait 5 minutes, vigorously shake the liquid out of all test tubes, fill the tubes to overflowing with distilled water, decant, vigorously shake out remaining liquid, repeat three more times, tap the inverted tubes on laboratory tissue.
4. Use the 5 mL syringe to add 200 uL of the PCB enzyme conjugate to all test tubes, shake test tube rack to mix.

5. Wait 5 minutes, vigorously shake the liquid out of all test tubes, fill the tubes to overflowing with distilled water, decant, vigorously shake out remaining liquid, repeat three more times, tap the inverted tubes on laboratory tissue.
6. Use a new 5 mL syringe to add 200 uL of substrate to all test tubes, use another new 5 mL syringe to add 200 uL of chromogen to all test tubes, shake test tube rack to mix.
7. Wait 5 minutes, use a 12.5 mL syringe to add 500 uL of Stop Solution to all test tubes; and
8. Add 1 mL of stop solution to the blank test tube and insert into the left well of the spectrophotometer, dry the outside of each test tube and place in the right well of the spectrophotometer, measure the absorbance of the test tube, repeat for all test tubes.

C. Interpretation of Test Results

- Samples with absorbance values greater than or equal to the values of the 5 ppm standard contain less than 5 ppm PCB.
- Samples with absorbance values less than or equal to the 5 ppm standard may contain more than 5 ppm PCB.
- Samples with absorbance values greater than or equal to the 10 ppm standard contain less than 10 ppm PCB.
- Samples with absorbance values less than or equal to the 10 ppm standard may contain more than 10 ppm PCB.
- Samples with absorbance values greater than or equal to the value of the 50 ppm standard contain less than 50 ppm PCBs.

- Samples with absorbance readings less than or equal to the values for the 50 ppm standard may contain more than 50 ppm PCB.

Soil samples that were extracted with more than 1.0 ml of methanol per gram of soil require a correction factor in order to interpret the results. Multiply each of the calibrator concentrations by the ratio of methanol (ml) to soil (grams).